Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1954

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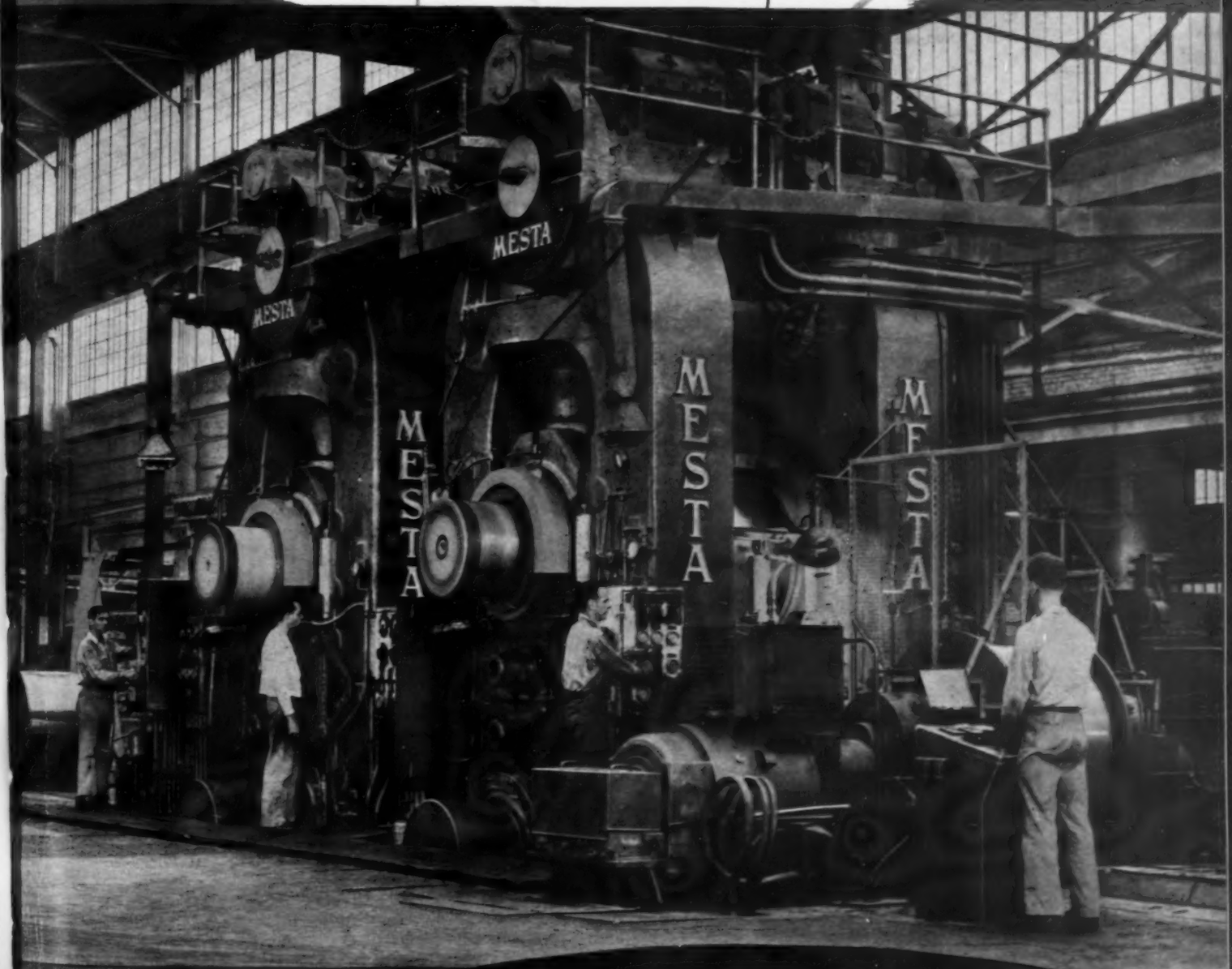
MESTA

HIGH-SPEED COLD MILLS



MESTA 42" FOUR-HIGH TWIN-STAND HIGH-SPEED SKIN PASS MILL

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

APR 28 1954

FOUR FIT IN THIRTY INCHES

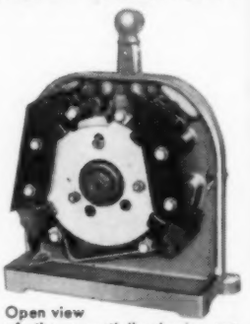
and Cutler-Hammer's NEW FLAT MASTER has grip release of off-position latch

In introducing Cutler-Hammer's New Flat Master, we don't have to tell an experienced steel man the advantage of being able to mount masters on 7½" centers. The New Flat Master is only 6 15/16" at greatest depth. This means these masters can be grouped in such a short span, the operator has any one in easy reach without stretching at all. It means he doesn't get so tired. It means his efficiency stays high.

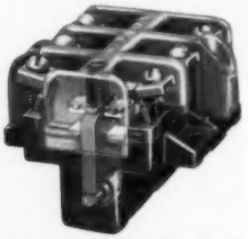
The advantages of the squeeze grip release of the off-position latch are equally compelling. Release results simply from tightening the normal grip. No extra motions. Less fatigue. And as easy and desirable as the squeeze grip release is in any position, it becomes a necessity when a master is mounted overhead.

These are but two of the many features making the Flat Master ideal for crane cab, open hearth charging machine and "all-vision" cab use. The Flat Master is designed throughout the better to meet steel mill needs. The rugged substantial cover lifts off straight up. The contact structure is simplified, all parts easily accessible, and easy to maintain. Movable and stationary contacts are readily replaceable, or the group assembly of 3 sets of contacts and operating rollers can be easily replaced as a unit. Twin break special alloy contacts, arc resistant molded supports, etc., provide long contact life and trouble-free service. There is ample wiring space. The sealed bearings are permanently lubricated. Many other features of fine, dependable performance recommend you get further information at once. CUTLER-HAMMER, Inc., 1269 W. St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

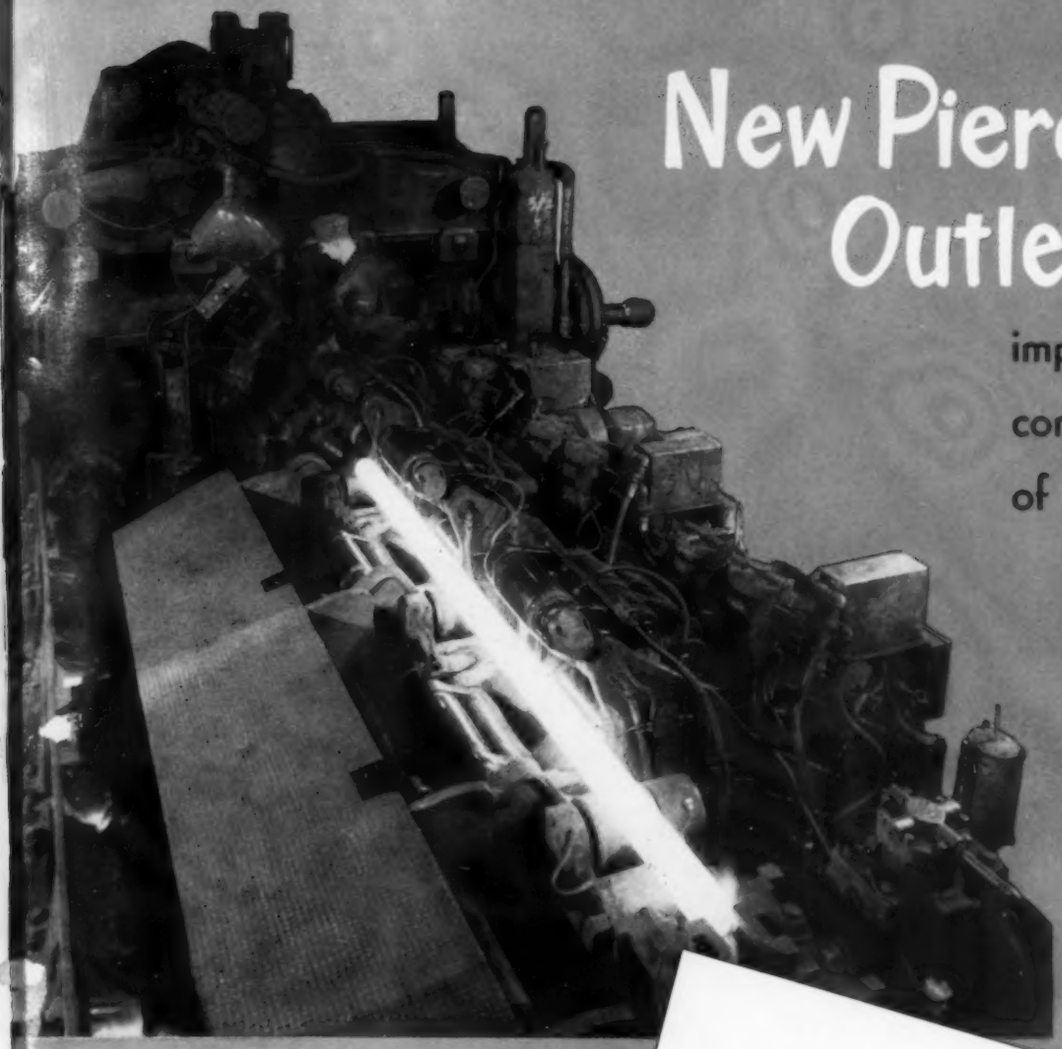


Open view of the essentially simple construction of the New Flat Master and standardized contact structures that provide 5 speed points in either direction.



Phantom view of one of 4 contact structures that are interchangeable with many other C-H masters and switches. Standardized, simplified, sturdy.

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 31, No. 4.



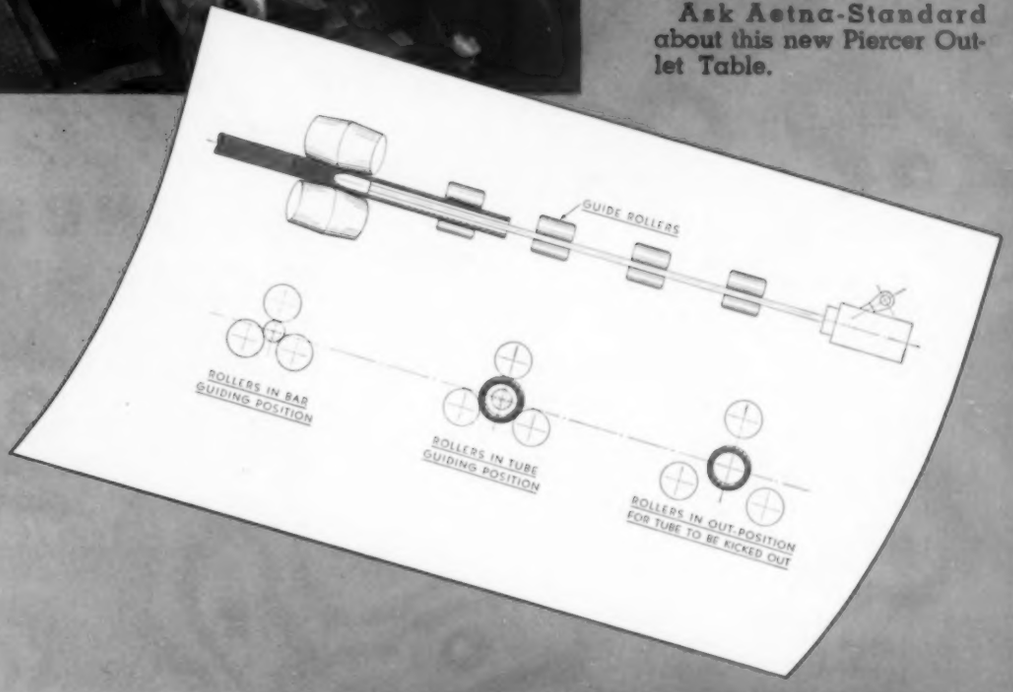
New Piercer Outlet Table

improves concentricity of tubes

The same rollers guide both piercer bar and tube, assuring three advantages: (1) positive guiding of bar; (2) improved outside tube surface; (3) more uniform concentricity from end to end of tube.

On the operating side, the setting for different rolling schedules (changes in bar or tube diameter) requires only a few minutes . . . without crane service.

Ask Aetna-Standard about this new Piercer Outlet Table.


GUIDE ROLLERS
ROLLERS IN BAR GUIDING POSITION
ROLLERS IN TUBE GUIDING POSITION
ROLLERS IN OUT-POSITION FOR TUBE TO BE KICKED OUT

features

1. Same rollers guide piercer bar and tube (see diagram).
2. Guide rollers open automatically from bar guiding to tube guiding position as pierced tube leaves piercing mill.
3. Indicators allow quick setting of guide rollers to suit respective mandrel bar and O. D. tube sizes.
4. Roller guides are adjustable for full range of piercing mill from minimum diameter bar to maximum O. D. tube.
5. Simple, rugged design.

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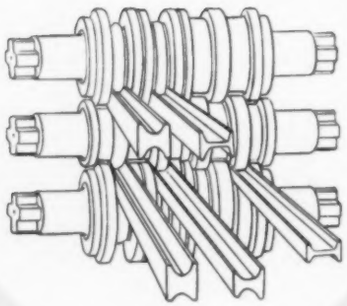

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- No periodic tightening of clamping nuts
- All standard sections same size
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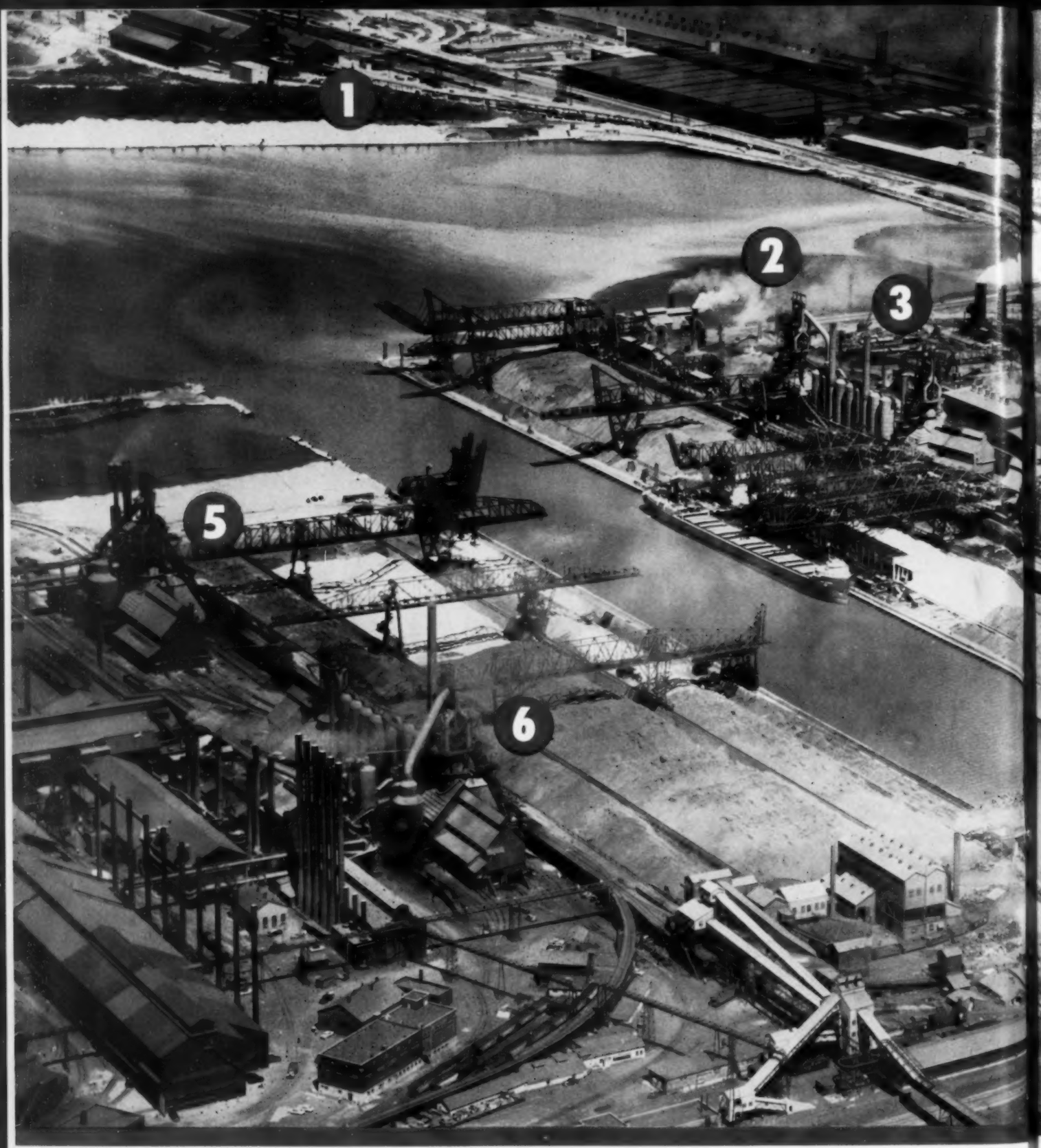


1 Inland Steel Company's No. 3 Open-Hearth Shop was designed and built by McKee in 1952. Capacity of the four furnaces is 750,000 tons annually with provision for future expansion.

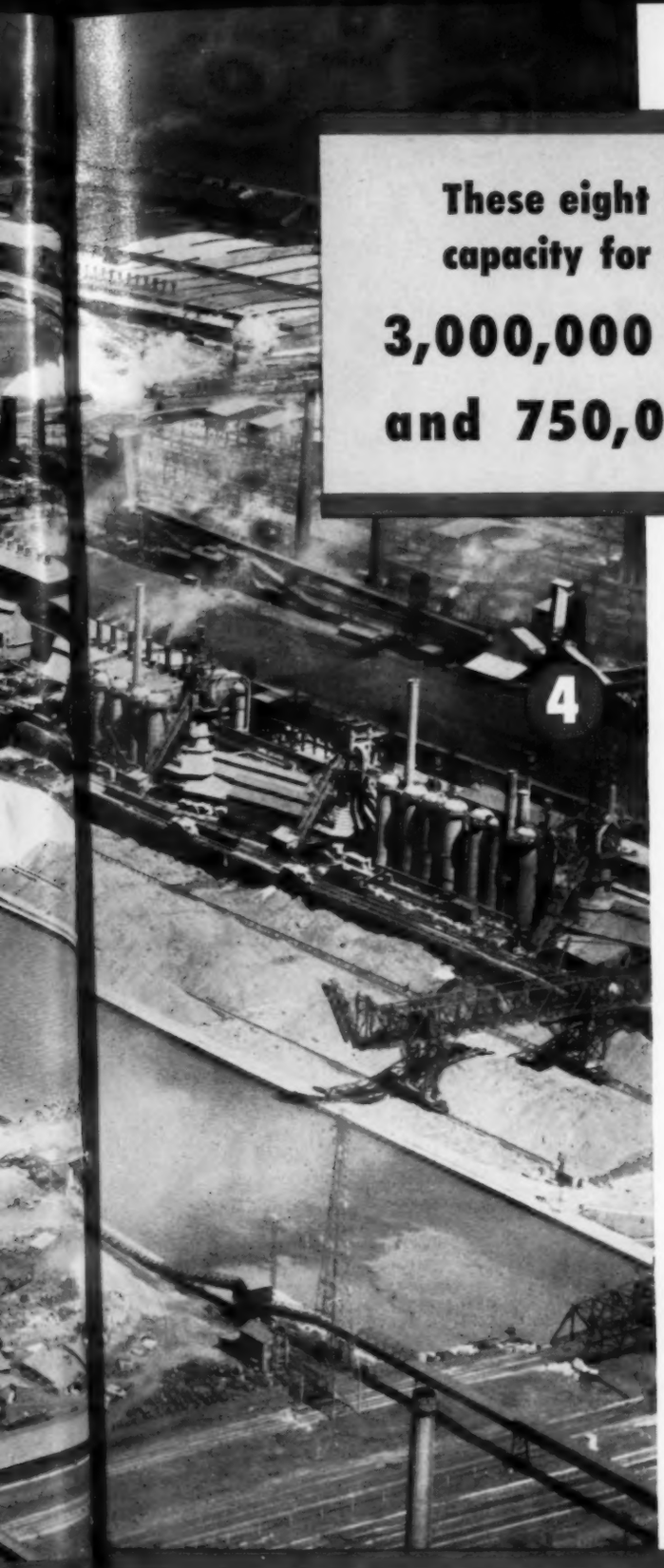
2 Inland No. 6 Blast Furnace designed and constructed in 1942 by McKee. With a 25′ 9″ hearth diameter, this furnace has a 450,000 ton capacity.

3 Inland No. 5 Blast Furnace, completed in 1938, was designed and built by McKee. Hearth diameter is 25′ 9″ and annual capacity 450,000 tons.

4 Inland No. 1 Blast Furnace was completely dismantled, redesigned and rebuilt by McKee in 1939. Annual production capacity is 300,000 tons. No. 1 Furnace has a 20-foot hearth diameter.

5 Youngstown Sheet & Tube Company's No. 3 Blast Furnace was completed in 1953. Designed and constructed by McKee, this furnace has a 28-foot hearth diameter and an annual capacity of 550,000 tons.

6 Youngstown No. 1 Blast Furnace, completed in 1948, was designed and built by McKee. Capacity is 480,000 tons annually, hearth diameter 26 feet.



These eight McKee-built plants have capacity for the annual production of

3,000,000 TONS OF PIG-IRON and 750,000 TONS OF STEEL

HERE, in a relatively small area, are eleven blast-furnaces and an open-hearth shop. Seven of the blast-furnaces and the four-furnace open-hearth shop were designed and constructed by Arthur G. McKee & Company. This is a typical cross section of the iron and steel industry in the last 20 years because it graphically portrays the fact that McKee has built more blast-furnaces than any other single organization.

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British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto

7 Inland Blast Furnace A at Plant No. 3 has a 25′ 9″ hearth diameter and a capacity of 450,000 tons. Designed and built by McKee, it was completed in 1943.

8 Inland Blast Furnace B at Plant No. 3. Built at the same time as Furnace A, it has the same hearth size and capacity. These two furnaces form one of five sets of "twins" designed and built by McKee.

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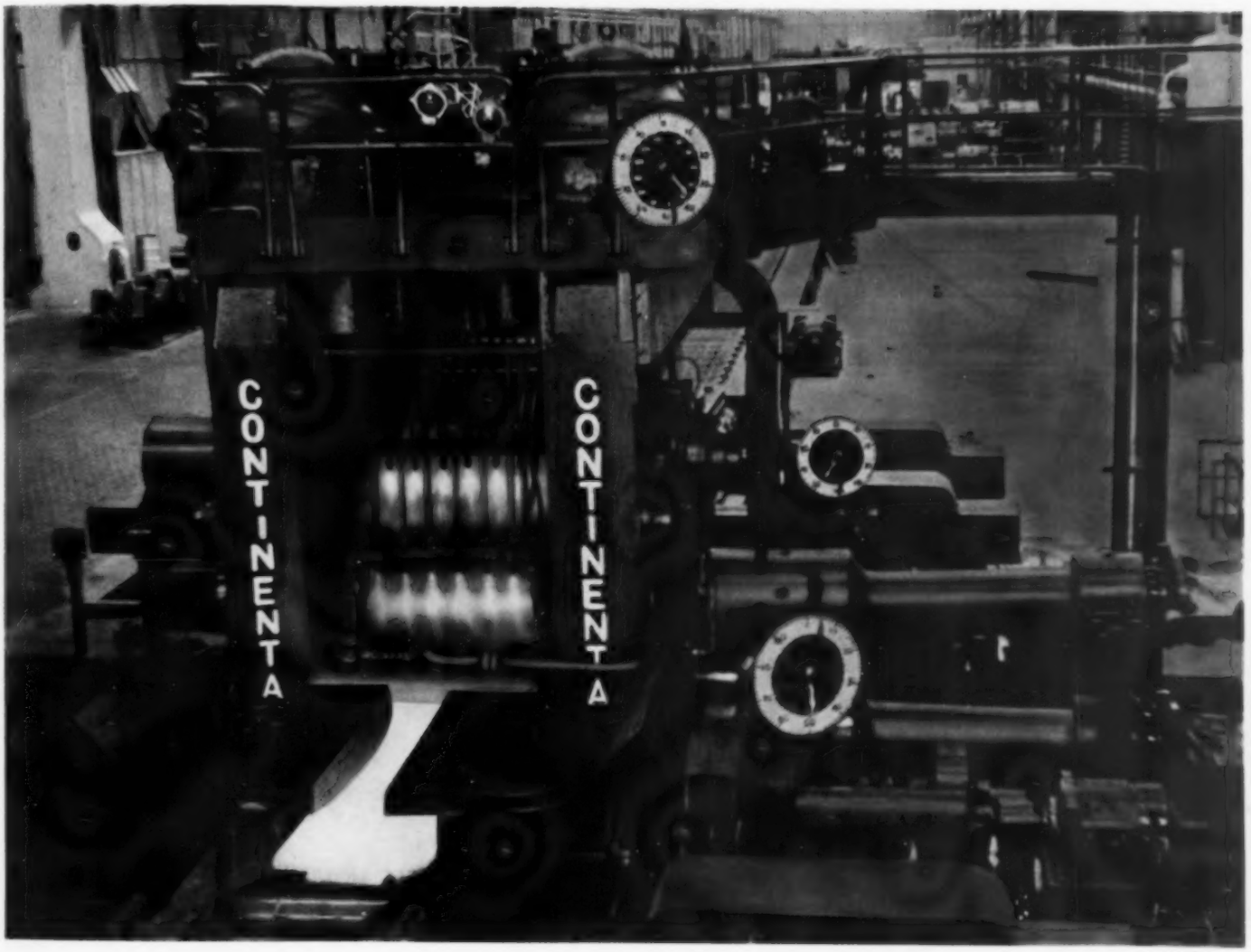
CONTINENTAL

FOUR-HIGH REVERSING HOT MILL WITH VERTICAL EDGER



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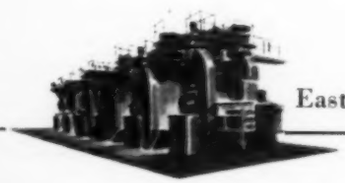

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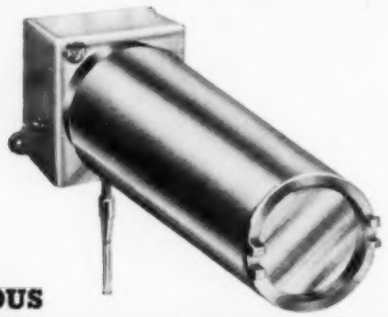

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Cut Pyrometer Maintenance Man-Hours by using the

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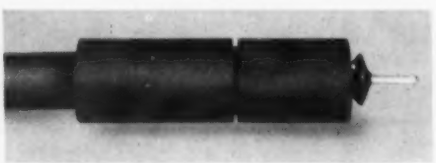
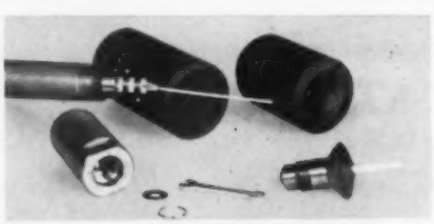
Immersion Couple ready for use. Graphite blocks, under spring tension, house the immersion end of the thermocouple element. The "hot" junction projects into a quartz sheath, cemented into a stainless steel plug.



FOR QUICK CHANGES *after each immersion, a retractor (not shown) releases the spring tension . . . graphite blocks slide back . . . quartz sheath is quickly replaced. Usually a supply of sheaths, cemented into spare plugs, is kept on hand to speed changes.*



FOR QUICK REPAIRS *to the junction, terminal screws are loosened, sufficient wire is drawn down from its storage in the tube, a new junction is formed, and the unit is reassembled, in a matter of minutes.*

Time spent in servicing immersion equipment is being sharply reduced by the use of the L&N Immersion Thermocouple for bath-temperature measurements in open-hearth or electric arc furnaces. Routine maintenance—changing the protective quartz tip after each immersion, for example—is quickly performed by the helper himself, right at the furnace. By fully applying the principle of prefabricated, interchangeable parts, L&N helps you keep the Immersion Thermocouple out of the instrument shop and on the job.

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Full details of this equipment—including the Speedomax recorder and signal system which guide the operator through each step of the measurement—are contained in Process Data Sheet 643(1), available on request. Or perhaps an office demonstration of a desk-model of the thermocouple before an interested group in your plant might be arranged. Just contact our nearest office, or write us at 4942 Stenton Avenue, Philadelphia 44, Pa.

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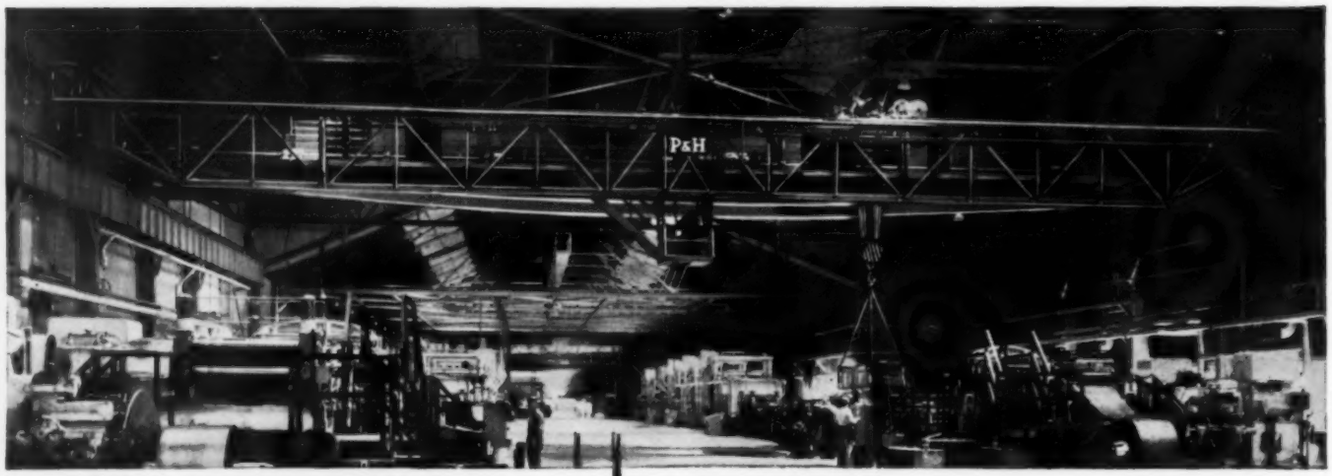

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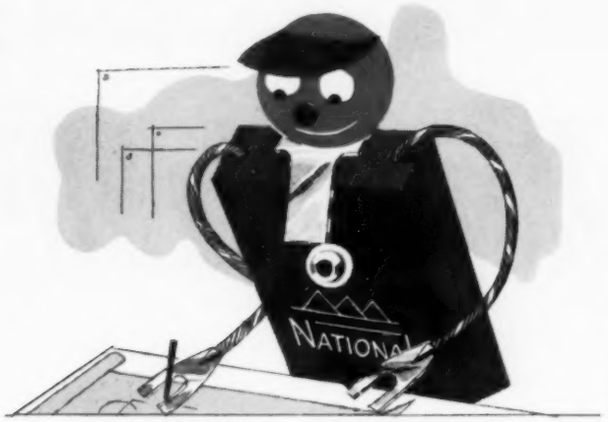

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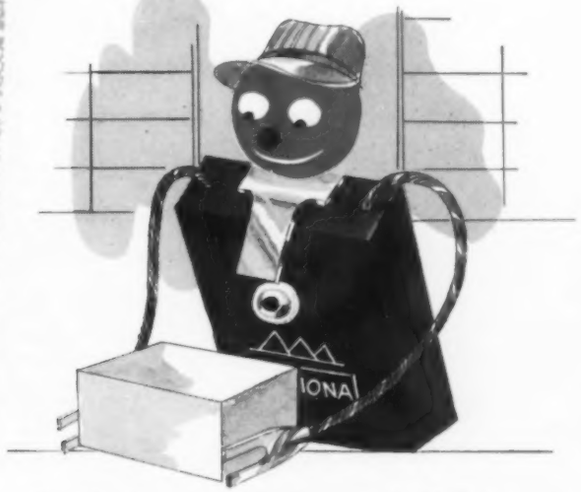

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Air distribution control
Bleeder valve control
Gas distribution metering and control
Flow meters for water, steam
Stove burner gas input and gas-air ratio control

coke ovens

Exhauster and booster controls
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Stack draft control
Underfiring gas pressure control
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Furnace pressure control
Oxygen flow metering and control
Reversal control
Btu meters for gas firing
Draft and pressure recorders
Flow metering for steam, oil, gas or water

soaking pits

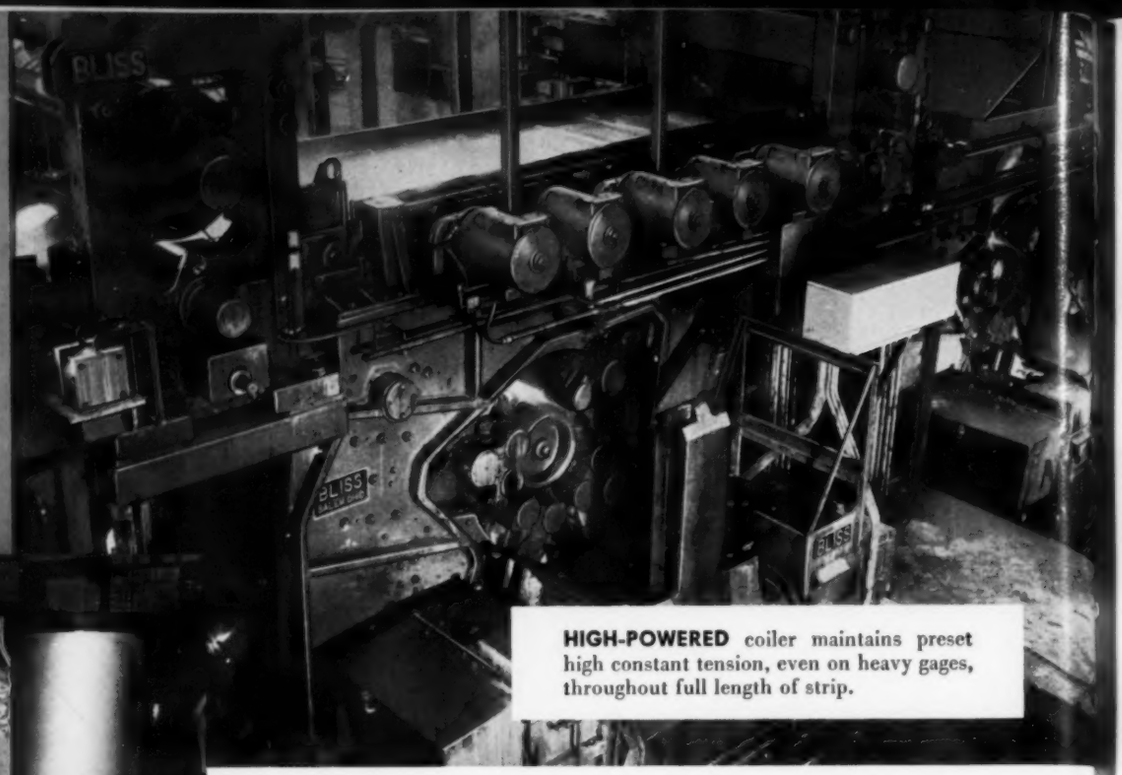
Fuel input control
Fuel-air ratio control
Reversal control
Gas pressure control
Furnace pressure control
Waste gas flue draft control
Draft and pressure recorders
Flow metering for steam, oil, gas or water

gas distribution systems

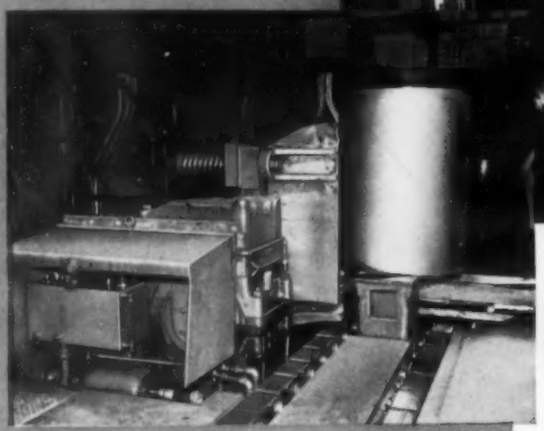
Gas mixing stations
Gas pressure control
Sequential distribution control
Pressure stabilization control
Gas flow meters—with automatic compensation for pressure and temperature
Btu meters

boiler houses

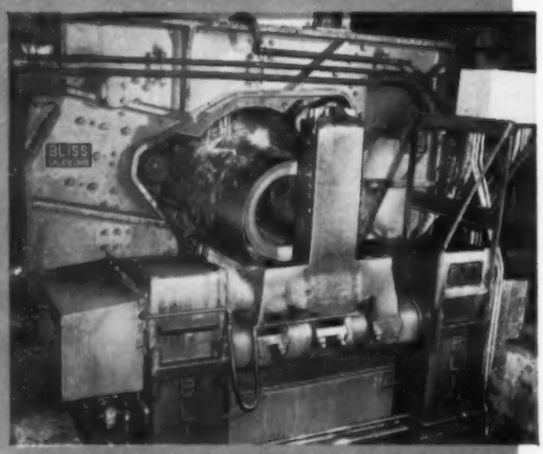
Steam pressure control
Automatic control of single or multiple fuel input, firing separately or simultaneously
Control of load distribution
Fuel-air ratio control
Furnace draft control
Boiler drum water level control
Flow metering for steam, oil, gas and water
Automatic compensation of flow readings for pressure and temperature variations
Pneumatic and electric signal transmission



HIGH-POWERED coiler maintains preset high constant tension, even on heavy gages, throughout full length of strip.



TIGHTLY-WOUND, uniformly-coiled strip, protected from surface and edge damage results from this unit.



QUICK EJECTION and downending are facilitated by special mechanism. Rapid unloading cycle eliminates terminal bottleneck.

BLISS hot strip coiler at Ford promotes QUALITY CONTROL

For high speed coiling and all-around efficiency in "rolling up" hot band off the Hot Strip Mill, Bliss mandrel-type hot mill coilers have demonstrated their ability in major steel plants. Latest of these installations is this 66" coiler at Ford's River Rouge plant.

Due largely to the features of the Bliss mandrel, desired coil and metal characteristics are achieved to a degree previously unattainable; e.g., by coiling the strip steel on an arbor with high constant tension applied, *coils are more tightly and uniformly wound.* Thus, *surfaces and edges are better protected, and better metallurgical characteristics are realized.* And after coiling, the reliable collapsing feature of the mandrel greatly facilitates the stripping of the coil.

Designed for versatility of application, too, the Bliss coiler accommodates a range of speeds, strip widths, and gages. And it's a high-speed coiler capable of handling the largest coils.

If you are interested in modern material handling equipment for steel plants, it's wise to consult Bliss. Meanwhile, write for your free copy of our new 60-page brochure. Ask for Bulletin 40-A.

Remember: BLISS **for Presses, ROLLING MILLS, Special Machinery**

E. W. Bliss Company • General Office: Canton, Ohio

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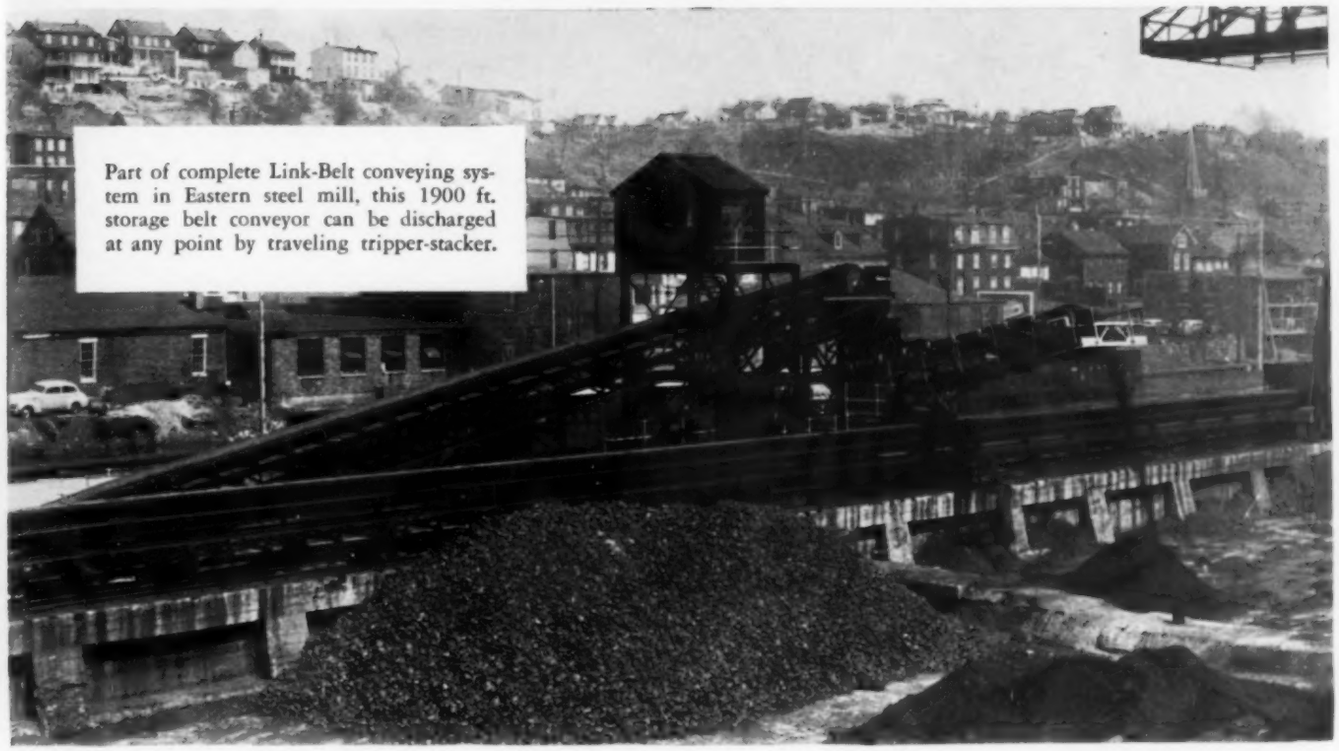
Subsidiary: The Die Supply Company, Cleveland, O. • E. W. Bliss (England) Ltd. • E. W. Bliss Company (Paris) France

U. S. Plants in Canton, Salem and Toledo, Ohio; and Hastings, Michigan. Branch Offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo and Toronto, Canada. West Coast Representatives: Moore Machinery Co., Los Angeles and San Francisco; Star Machinery Company, Seattle. *Other representatives throughout the world.*



Part of complete Link-Belt conveying system in Eastern steel mill, this 1900 ft. storage belt conveyor can be discharged at any point by traveling tripper-stacker.

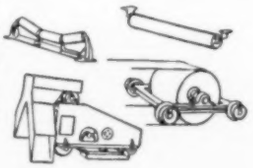
SURE ROAD TO LOWER HANDLING COSTS

... carry the load via Link-Belt belt conveyors

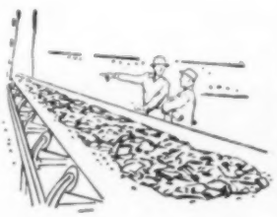
LINK-BELT offers you the "total engineering" so necessary for top efficiency

DESIGNED FOR OVERALL EFFICIENCY—Because of its unrivaled experience, Link-Belt can do a better job of gathering and analyzing all data. Proposals reflect this understanding of the most practical way to fit individual conveyors into your overall system requirements for best results.

BUILT FOR LONG-LIFE PERFORMANCE—Link-Belt manufactures all components and related feeders and conveyors. You are assured of the right equipment because of this breadth of line. And Link-Belt will supply the highest grade belts engineered to the specific job.



DELIVERS FULL RATED CAPACITY—Link-Belt follows through on every detail of the job, including electrical controls and even wiring and foundations. What's more, Link-Belt will furnish experienced erection superintendents, staffs and skilled crews at the customer's request.



ASSURES SATISFACTORY PERFORMANCE—When you rely on Link-Belt as a single source for your complete system, we accept responsibility for placing it in full operating readiness. We will also supervise modernization of existing systems. For all the facts call your nearby Link-Belt sales representative.

LINK-BELT

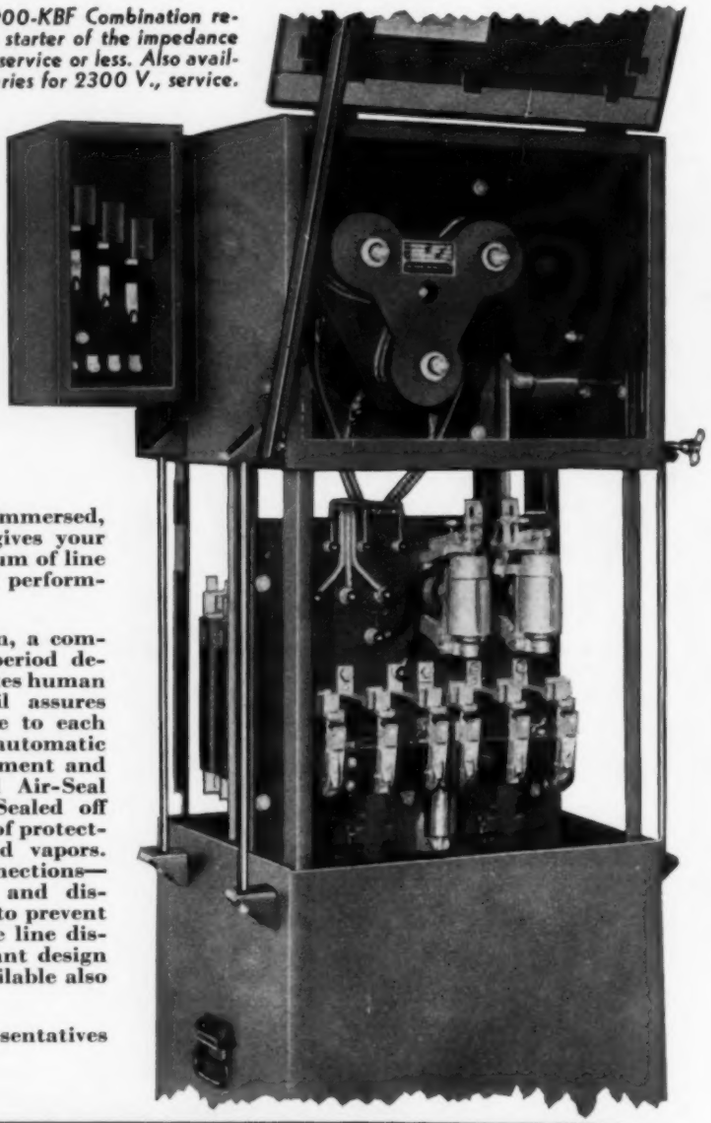
BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13.405-C

Oil Immersed

Rowan Type 900-KBF Combination reduced voltage starter of the impedance type, 600 V., service or less. Also available in 950 series for 2300 V., service.



ROWAN
Type 900 Series
REDUCED VOLTAGE STARTER

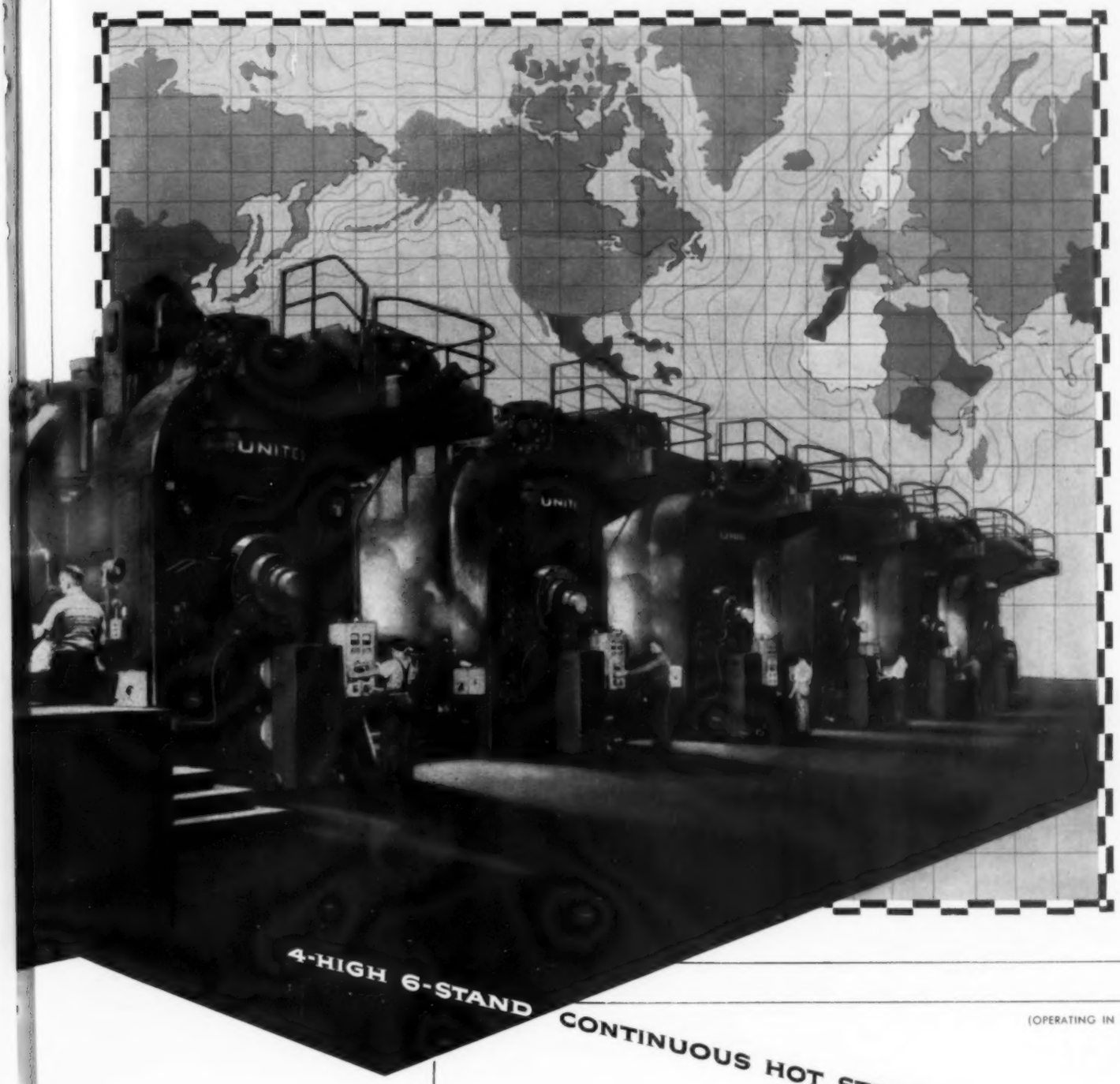
Push button operated—fully automatic—this oil immersed, reduced voltage starter of the impedance type gives your induction motors a smo-o-oth start with a minimum of line disturbance. Check its design, construction, and performance features:

√ Closed transition type—utilizes for acceleration, a combination of current and time. √ Acceleration period dependent upon driven equipment and load—eliminates human element. √ Continuous wound impedance coil assures freedom from tap failures—impedance adjustable to each application. √ Magnetic overload relays with automatic reset—provides a combination of inverse time element and instantaneous operation. √ Rowan time-tested Air-Seal fuses—dependable short circuit protection. √ Sealed off centralized wiring compartment—eliminates need of protecting incoming and outgoing leads from oil and vapors. √Provision for straight through conduit connections—facilitates installation and inspection. √Tank and disconnect mechanism is mechanically interlocked—to prevent the lowering of the tank before disconnecting the line disconnect switch. √ Enclosure is of weather-resistant design to meet the requirements of NEMA Type XI—available also for Class I Group D locations.

Complete information available from Rowan representatives in principal cities of the United States.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



4-HIGH 6-STAND CONTINUOUS HOT STRIP MILL

(OPERATING IN WALES)

DESIGNED AND BUILT BY

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

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Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

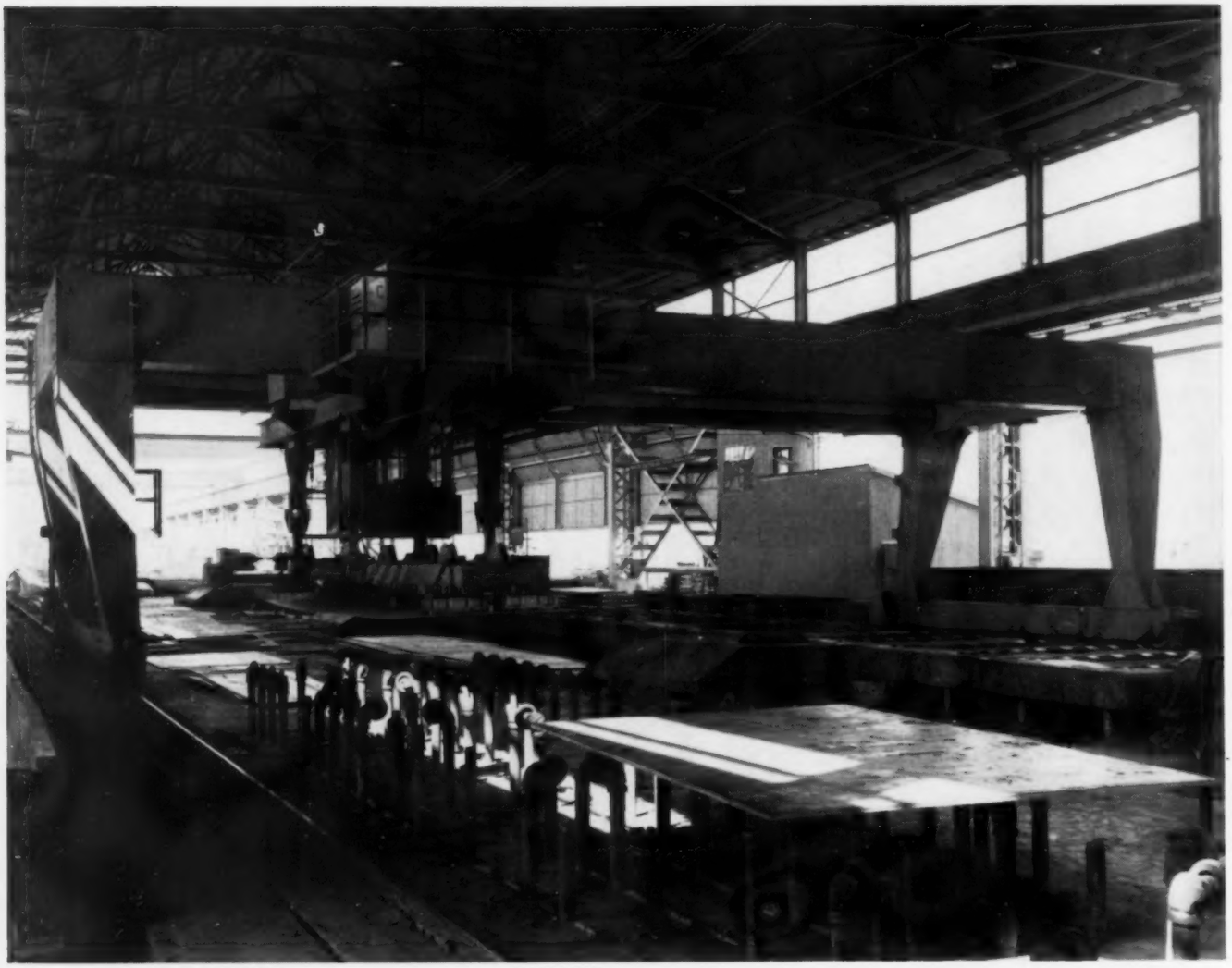


PLATE HANDLING GANTRIES . . . *by "Shaw-Box"*

Plate Handling Gantries are another specialty in the broad "Shaw-Box" Line of Steel Mill Cranes. Ruggedly built to give dependable service, they contain many exclusive mechanical advantages and features which give fast operation at lowest cost. Here are a few of these advantages — variable flux control (patented), lifting magnets that discharge one plate at a time after picking up several, rope lifts with guides to restrict swing of the load.

In "Shaw-Box" Plate Handling Gantries — whether built to an individual mill's or A.I.S.E. specifications — you get the added advantages that come from "Shaw-Box" engineering, fine workmanship, and precision manufacturing methods. These added advantages insure crane performance which makes "Shaw-Box" Gantries, for the work they do, the least expensive cranes to buy and use!

SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

"Shaw-Box" CRANES

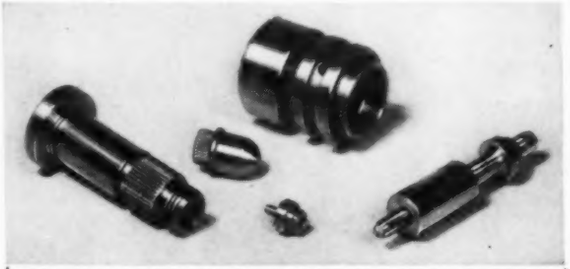
MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial Instruments and Aircraft Products.

For Atlantic Automatic Co., Cleveland, Ohio:

Tool Life Increased Over 200%!



PARTS FOR GEARS & CAR TRANSMISSIONS are just a few of the many delicate machine tool products Atlantic turns out. Cities Service Chillo Cutting Oil has helped Atlantic maintain their great reputation for quality products.

For the services of a Cities Service Lubrication Engineer... Write Cities Service Oil Company, Sixty Wall Tower, New York City 5, New York.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

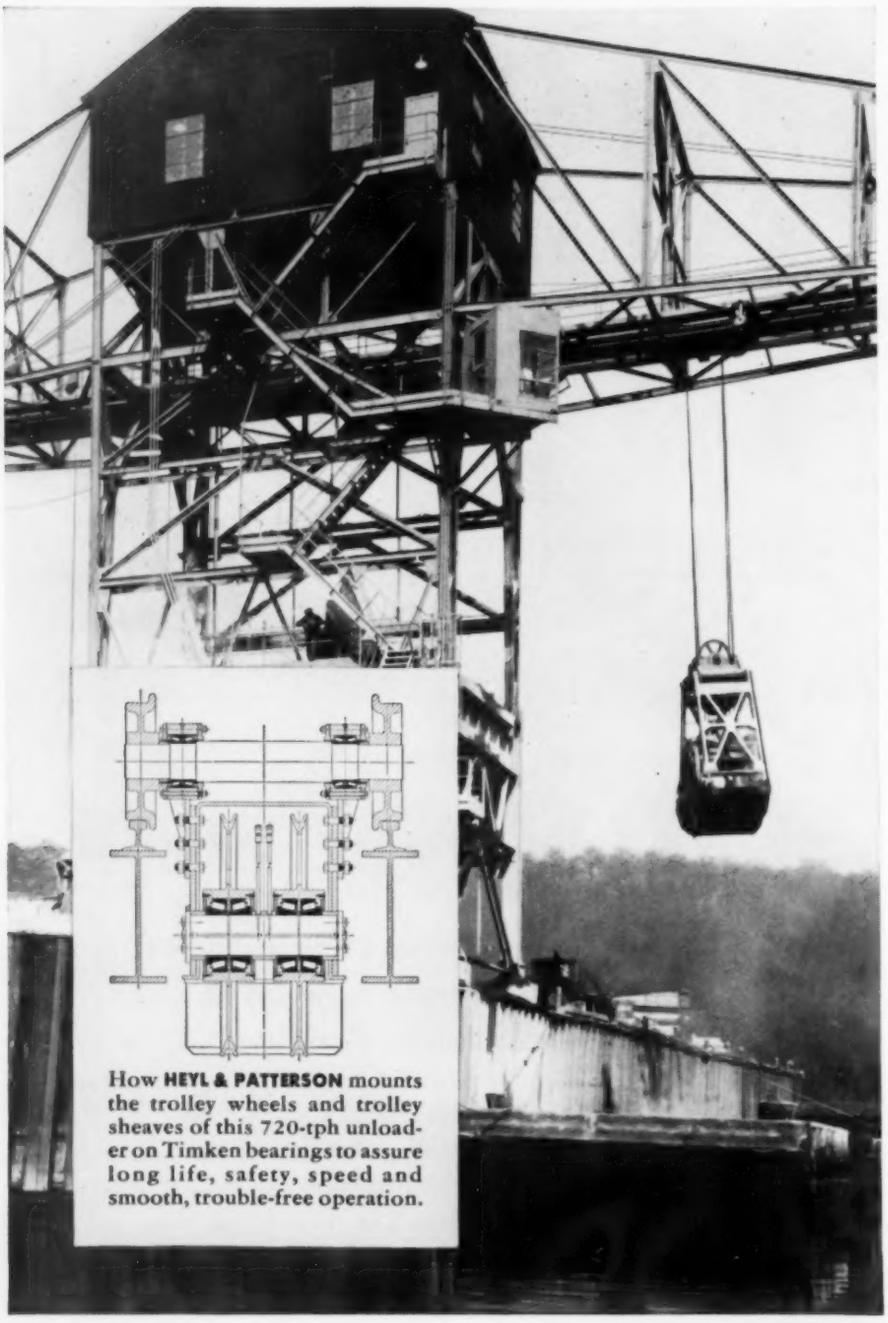
"Cities Service Chillo Cutting Oil Has Proved To Be The Difference Between Ordinary And Quality Production In Our Shop!"

Here's Atlantic Automatic's story in their own words: "One of our tougher jobs recently was machining SAE 446 Stainless Steel with two forming, one threading and three drilling operations. The critical operation was drilling a .025 inch diameter hole, ⅛ inch deep. The drill would soon pack with chips and break. When a Cities Service Lubrication Engineer was called in, he recommended our using Chillo 44.

"This light-colored oil did the trick. DOWN TIME WAS CUT IN HALF AND DRILL LIFE INCREASED OVER 200%!

"We use Cities Service Chillo 44 to machine all types of metals covering a range of machinability from brass to stainless on our Brown and Sharpe 00G, 0G and 2G Automatics. It has proved to be the difference between ordinary and quality production in our shop!"

Unloads 720-tph smoothly with TIMKEN® bearings on trolley wheels and sheaves



How **HEYL & PATTERSON** mounts the trolley wheels and trolley sheaves of this 720-tph unloader on Timken bearings to assure long life, safety, speed and smooth, trouble-free operation.

IMAGINE the strain on this barge unloader's trolley wheels and sheaves as they make 120 trips per hour, carrying 20 tons of bucket and load per trip! They not only have to take the radial load of the bucket's weight, but also must handle the rugged thrust loads caused by the bucket's swing.

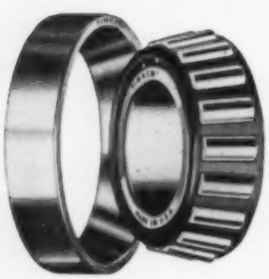
But these tough loads are no problem for this Heyl & Patterson unloader because its trolley wheels and sheaves are mounted on Timken® tapered roller bearings. The tapered construction of Timken bearings enables them to take any combination of radial and thrust loads. And Timken bearings provide extra load carrying capacity because of line contact between their rollers and races.

In addition, Timken bearings help make a 30-second unloading cycle possible because their true rolling motion and incredibly smooth surface finish practically eliminate friction. Sheaves and wheels turn easily, smoothly.

Another benefit: Timken bearings absorb the punishing jolts delivered to the sheaves and trolley wheels because their rollers and races have tough, shock-resistant cores under hard, wear-resistant surfaces.

To get all these advantages, always specify Timken bearings in the equipment you build or buy. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

WE MAKE OUR OWN STEEL

The special grade alloy steel which gives Timken bearings their strength and resistance to wear is made in our own steel mills.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬯ AND THRUST → ⬯ ← LOADS OR ANY COMBINATION →⬯←

Patent Reviews

By MELVIN NORD
Patent Attorney
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . patents reviewed cover period December 8, 1953 through December 29, 1953 . . . .

HOT TOP COVER

▲ U. S. 2,663,920, issued Dec. 29, 1953 to Benjamin F. Anthony and assigned to The Ferro Engineering Co., describes a hot top cover for use in hot topping killed steel.

Unless some sort of cover is used, as much as 25 per cent of the heat loss in hot topping is accounted for by the heat which escapes from the surface. Generally, ingot sinkheads are covered by shoveling some bulk material such as rice or oat hulls, straw, sand, lime, waste refractory fines, etc. Rigid covers which have been tried are generally good for only a single use, because of their fragility and because of thermal shock. Attempts to improve the situation by encasing the refractory material in metal frames have been made, but these suffer from the disadvantages of heavy weight, high cost of fabrication, and tendency to warp.

The new type of cover is shown in Figures 1-4. As shown in Figure 2, the hot top consists of a housing made of iron castings 10 and 11 lined with refractory blocks 12 and 13 and a single-use bottom ring 14. A refractory veneer 15 may also be applied, as shown. The hot top cover 16 consists of a slab of rigid refractory 17 which may be a single block shaped to fit loosely within the upper end of the hot top, or it may be built of several blocks cemented together. Porous fire brick of the grade known as 2600 F brick is the preferred material. Its insulating qualities are much superior to those of ordinary 2800 F brick, but it is porous and fragile. Its comparative light weight is advantageous but it is easily damaged by shock and abrasion.

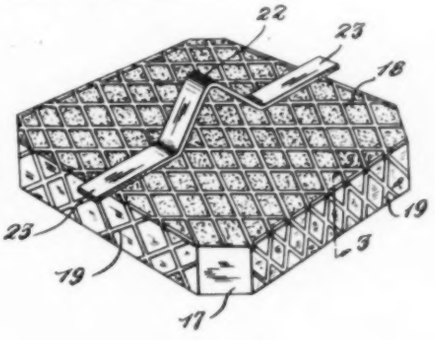
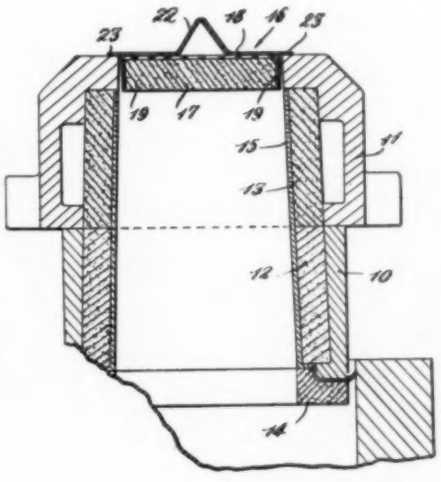


Figure 1

Figure 2



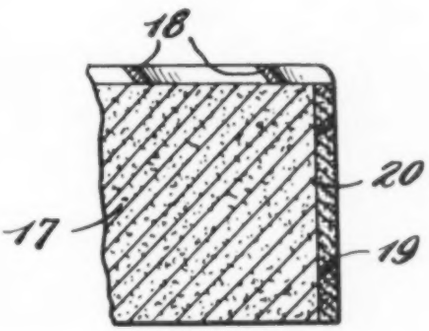


Figure 3

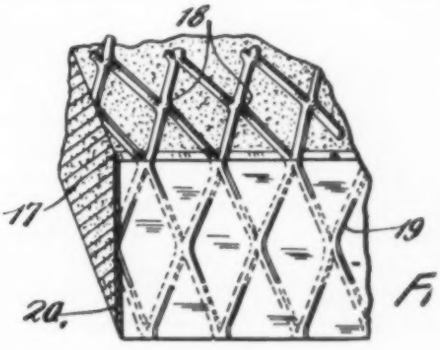


Figure 4

In order to protect the slab 17 from breakage or deterioration, the slab is encased in an inverted pan 18 of expanded metal. A sheet of proper size is bent to provide the side edges 19. As shown in Figures 3 and 4, a layer of mortar 20 is applied to the sides and scraped off flush with the outer surface of the expanded metal, filling the interstices and forming a tight

bond between the slab and the housing. A bent metal strip 22 is provided as a handle. The ends 23 of the strip extend beyond the cover and act as supports for the cover on the hot top casting 11. The strip is tack-welded to the top of the casing.

Further details concerning the use of the cover in practice are given in the patent specification.

APPARATUS FOR FLUFFING SLAG

U. S. 2,661,575, issued Dec. 8, 1953 to Truman H. Kennedy and assigned to United States Steel Corp., discloses a new type of apparatus for fluffing slag. The product is claimed to be highly satisfactory for use as a light weight aggregate in concrete.

The apparatus is shown in Figure 5. A number of buckets 10 are carried on an endless-chain conveyor. Wet slag fines are fed to the buckets from a hopper 13, a paddle-wheel gate 15 controlling the supply so that the buckets are partly filled. A slag runner 17 and trough 18 are mounted above the conveyor, receiving molten slag from a ladle 19 and delivering it to the conveyor. The molten slag forms a layer 20 on top of the wet fines 16 in each mold. As the travel of the mold continues, the heat of the molten slag vaporizes the water adhering to the fines. The resulting steam agitates the molten slag, causing it to become completely fluffed and incidentally cooled substantially.

The contents of the mold are dumped onto a sloping screen 23, causing a separation of the fines from the particles suitable for use as concrete aggregate. The larger particles fall into a bin 24. The fines fall onto a belt conveyor 25, which carries them upward. Before reaching the upper end of this conveyor, the fines are sprayed with water, after which they are returned to the hopper. A small amount of fines should be diverted from time to time, in order to remove the small amount of excess fines formed during the process.

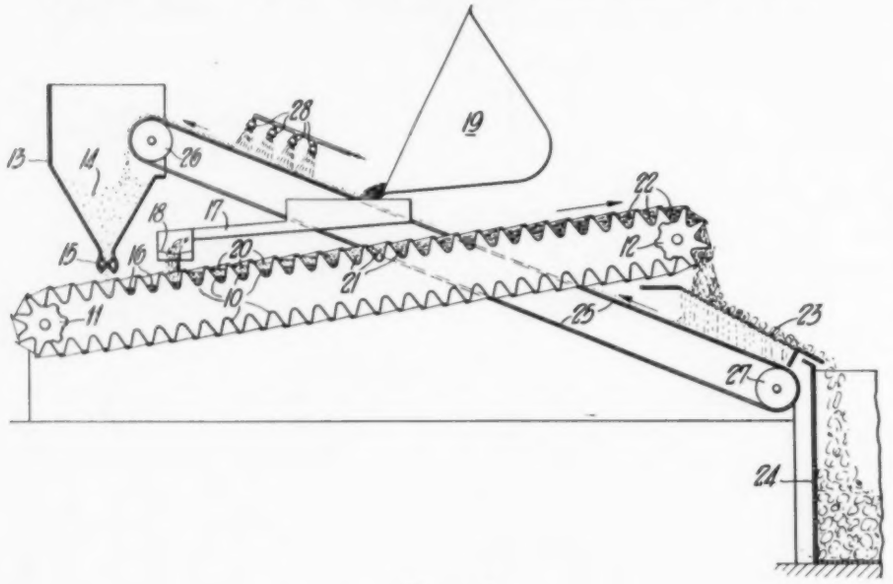


Figure 5

REGENERATION OF SPENT PICKLE LIQUOR

In U. S. 2,662,812, issued Dec. 15, 1953 to Joseph A. Shaw and assigned to Koppers Co., Inc., spent pickle liquor is regenerated and ferrous sulphate monohydrate recovered.

The pickle liquor is evaporated to a point at which the salts (primarily ferrous sulphate) are just short of the saturation point. Strong sulphuric acid is then added. Upon cooling, ferrous sulphate monohydrate precipitates out, leaving only a trace behind in the solution. The ferrous sulphate monohydrate can be readily smelted for recovery of sulphur oxygen gases. The filtrate, which is virtually entirely a sulphuric acid solution, may be used for further pickling.

The addition of sulphuric acid without prior evaporation leads to the precipitation of copperas, $FeSO_4 \cdot 7H_2O$, which can be treated for recovery of sulphur only with difficulty. The same is true of evaporation without the addition of sulphuric acid.

WASHER FOR BLAST FURNACE GASES

U. S. 2,663,557, issued Dec. 22, 1953 to Waring L. Dawbarn and assigned to Arthur D. Little, Inc., describes a washer for blast furnace gases which avoids the hazard of blowing all the water out of the bottom of the washer by a sudden increase in pressure. The apparatus described maintains a body of liquid in the hopper at the bottom of the gas washer, regardless of gas pressure fluctuations within the washer, so that escape of gases is prevented.

TWO-STAGE REDUCTION OF IRON ORE

In U. S. 2,663,632, issued Dec. 22, 1953 to Assur G. Oppegaard and assigned to National Lead Co., iron ore is reduced in two stages. A reduction is carried out first with solid fuel such as coke, and then the material is transferred to another furnace where gas reduction is carried out. The gases from the gas reduction furnace pass directly into the coke reduction furnace and are fully burnt there, being used as fuel.

A high thermal efficiency is claimed, since the exit gases are completely burnt and the product leaves the second reduction furnace at a low temperature, of 600 or 700 C.

REMOVAL OF SLAG FROM SLAG POCKETS OF OPEN HEARTH FURNACES

In U. S. 2,664,284, issued Dec. 29, 1953 to Robert A. Fausnaught and assigned to Haws Refractories Co., a method and apparatus for removing slag from slag pockets by explosive blasting is described.

Hollow refractory tiles are mounted in the base of the slag pocket before the start of a furnace campaign. During the furnace campaign, the slag collects over the refractory tube in a hard dense layer. At the end of the furnace campaign, an explosive charge is inserted in the tube and is detonated to rupture the refractory tube and break up the layer of slag.

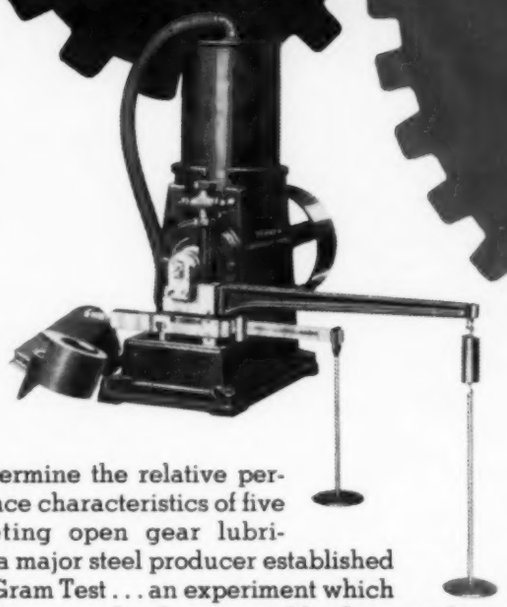
CAPSULE FOR SLOW RELEASE OF A REAGENT IN A LADLE

In U. S. 2,662,008, issued Dec. 8, 1953 to Joseph K. Stone, Jr., and as-

INDEPENDENTLY CONDUCTED

4-GRAM TEST

—PROVES LEADOLENE Klingfast BEST FOR LUBRICATING OPEN GEARS



To determine the relative performance characteristics of five competing open gear lubricants, a major steel producer established the 4-Gram Test . . . an experiment which reproduces as closely as possible the actual service conditions encountered in open gear and sleeve bearing lubrication.

In this test the Timken Testing Machine, recognized as standard equipment for testing lubricants, was modified slightly to reproduce more precisely actual service conditions. The hardened and ground steel block and cup, indicated at right, normally is under constant lubrication. However, in the 4-Gram Test the flow of lubrication was cut off and 4 grams of the lubricant being tested were applied at room temperature. The machine then was set in motion and watched closely for signs of scoring.

Five lubricants, all accepted in industry as "good quality," were tested. *Results of the test showed that LEADOLENE KLINGFAST gave over 3½ times the service of the next best lubricant and up to 6 times the service of the other lubricants tested.*

Since open gears are lubricated periodically and not constantly, the pH-ilm must have lasting characteristics. Thus, this test is truly representative of actual field operation tests for open gears. The enduring action together with extremely high pH-ilm strength guarantee the machine actual lubrication and protection.

In testing . . . and more important, in actual service . . . LEADOLENE KLINGFAST regularly gives comparable performances. A product of 76 years of manufacturing experience, it is a lead-based lubricant with an "Indestructible pH-ilm," capable of withstanding pressures up to 50,000 psi. With LEADOLENE KLINGFAST you profit in two ways: from lowered lubrication costs due to less frequent application, and from greater service life from the machinery being lubricated.

Write for technical data or samples for your own testing.

THE BROOKS OIL CO.

Since 1876

Executive Offices and Plant.....CLEVELAND, OHIO
Executive Sales Offices.....PITTSBURGH, PA.
Canadian Offices and Plant.....HAMILTON, ONTARIO
Cuban Office.....SANTIAGO de CUBA

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Results OF 4-GRAM TEST

LEADOLENE KLINGFAST
30 MINUTES
without scoring or failing.

LUBRICANT "A"
5 MINUTES
A high grade compound scored at 5 minutes and failed in 12 minutes.

LUBRICANT "B"
8 MINUTES
A reputable lubricant of residual nature scored and failed in 8 minutes.

LUBRICANT "C"
6 MINUTES
A good lead compounded extreme pressure lubricant scored and failed in 6 minutes.

LUBRICANT "D"
6 MINUTES
A lead-compounded lubricant scored and failed in 6 minutes.

signed to United States Steel Co., a method of slowly releasing a deoxidizing, desulphurizing, or fluxing element into the ladle, even when the reagent has a specific gravity lower than that of molten steel. The method is especially applicable when the reagent is to be vaporized.

As shown in Figure 6, a metal capsule 10 is provided with a bore 12 containing the reagent, for example magnesium. When the capsule is

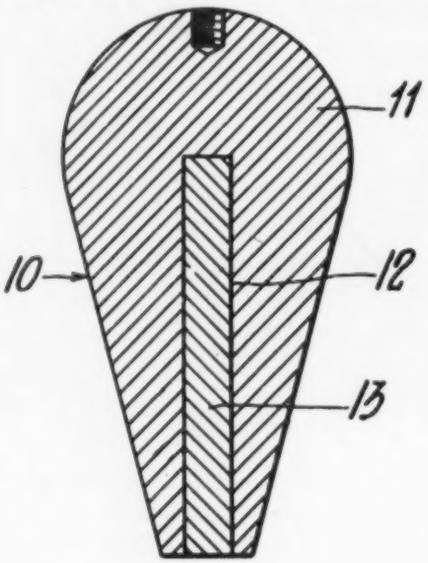


Figure 6

dropped in a ladle of molten steel, the magnesium begins to vaporize at the bottom of the bore. As the heat of the bath penetrates the wall of the capsule, more magnesium vaporizes. The vapors will be released gradually and will therefore rise slowly through the bath as bubbles, providing a good opportunity for the desired reaction to take place.

Other modifications of the design of the capsule are also given in the patent.

Patent No.	Date	Subject	Inventor or Assignee
2,661,681	12/ 8/53	Hand stamp for marking metal slabs	United States Steel Corp.
2,661,853	12/ 8/53	Apparatus for charging billets into furnaces for heating prior to rolling or forging	Ray Gordon
2,661,857	12/ 8/53	Hold-down apparatus for industrial trucks	United States Steel Corp.
2,661,911	12/ 8/53	Adapter for metal strip uncoilers	United States Steel Corp.
2,661,948	12/ 8/53	Sheet pickup and feeder	United States Steel Corp.
2,661,949	12/ 8/53	Sheet piler end stop structure	Armco Steel Corp.
2,662,010	12/ 8/53	Cast tool steel	General Electric Co.
2,662,011	12/ 8/53	Abrasion and corrosion resistant white cast iron	The International Nickel Co., Inc.
2,662,053	12/ 8/53	Hermetic seal for coke oven doors	Walter T. Brown
2,662,104	12/ 8/53	Feed and current supply apparatus for consumable electrodes and method of operating furnaces using them	Allegheny Ludlum Steel Corp.
2,662,271	12/15/53	Method of joining sections of strip for a uniform-speed continuous-feed strip-treating line	United Engineering & Foundry Co.
2,662,406	12/15/53	Reference-junction compensator for thermocouple pyrometers	Weston Electrical Instrument Co.
2,662,630	12/15/53	Apparatus for handling metal sheets	Armco Steel Corp.
2,662,761	12/15/53	Open hearth furnace	The United Steel Companies Ltd.
2,662,763	12/15/53	Wind box for smelting machines	The Consolidated Mining & Smelting Co. of Canada, Ltd.
2,662,764	12/15/53	Oscillatory, direct-fired, stack-loaded melting furnace	Reda Pump Co.
2,662,819	12/15/53	Production of transformer and dynamo steels	Heinz Hofges and Ernst-Goebel
2,662,820	12/15/53	Method for producing cast iron	The Dayton Malleable Iron Co.
2,663,185	12/22/53	Hardness tester	Ernst Leitz
2,663,205	12/22/53	Forging process and apparatus	Cameron Iron Works, Inc.
2,663,558	12/22/53	Furnace conveyer element	Blaw-Knox Co.
2,663,559	12/22/53	Burner control for low-temperature heating operations such as galvanizing or annealing	V. L. L. Battershill
2,663,633	12/22/53	Production of iron powder by reduction of ferrous chloride in the gaseous phase with hydrogen	Republic Steel Corp.
2,663,635	12/22/53	Method of introducing magnesium into cast iron	The International Nickel Co.
2,664,019	12/29/53	Rolling machine	Leonard B. Henderson
2,664,200	12/29/53	Apparatus for electromagnetic separation of wet ores	Augustin L. J. Queneau
2,664,283	12/29/53	Control of furnaces for heating metal tubes or rods	Selas Corp. of America
2,664,352	12/29/53	Reduction of ferrous chloride in liquid form to elemental iron	Republic Steel Corp.
2,664,355	12/29/53	Ti-Mn-Fe alloys	The Battelle Development Corp.
2,664,369	12/29/53	Method of softening low-carbon medium-alloy steel	United States Steel Corp.

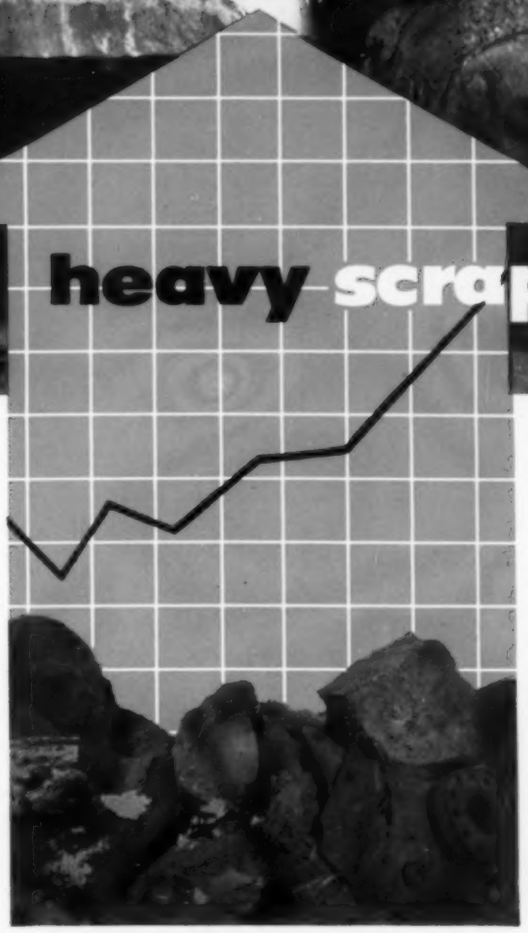
WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers.

If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

tripled



Steel and cast iron sections cut to charging box size

AIRCO TECHNICAL REPRESENTATIVES faced this problem in a large Eastern Steel Mill: How to increase scrap tonnage per man hour at lowered cost? Our recommendation: An Airco No. 41 Radiagraph gas cutting machine fitted with an Airco Style 6740 torch (shown above). Result? Tripled tonnage — all of it cut to charging box size . . . as buttons are cut down in one-third of the time! This technical advice and assistance is available to *every* Airco customer. If you have welding or cutting problems that affect *your* rate of production . . . ask us!

And remember, when you need oxygen . . . acetylene . . . nitrogen . . . and other industrial or rare gases, think of Air Reduction. A nation-wide distribution system is ready to supply your needs.

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MANIPULATOR

Alliance MANIPULATOR

INCREASES PRODUCTION FROM 200 TO 400%

This 75-ton Alliance Manipulator is the world's biggest. It handles ingots for ship shaftings . . . press columns, large naval gun barrels and other huge jobs.

At the International Nickel Company plant in Huntington, West Virginia, two 4-ton straight line Alliance Manipulators serve a single hammer . . . forging Monel metal ingots from 14"x14" down to 8"x8". They helped boost 8 hours' production to 250% of the former record capacity with less than half the number of men.

Alliance builds forging manipulators in capacities from 1 to 75 tons in the following types . . . straight line trolley only, straight line trolley with bridge, sluing trolley type, sluing trolley type with bridge and crane type. Some bridge type manipulators handle the entire job—charging, forging, discharging and delivering.

Users of Alliance Machine Company Manipulators report 200 to 400% increased production with a smaller crew.

If you are not using Alliance Manipulators now, you can increase production and save money by writing us today.

THE *Alliance* MACHINE COMPANY

Main Office: Alliance, Ohio

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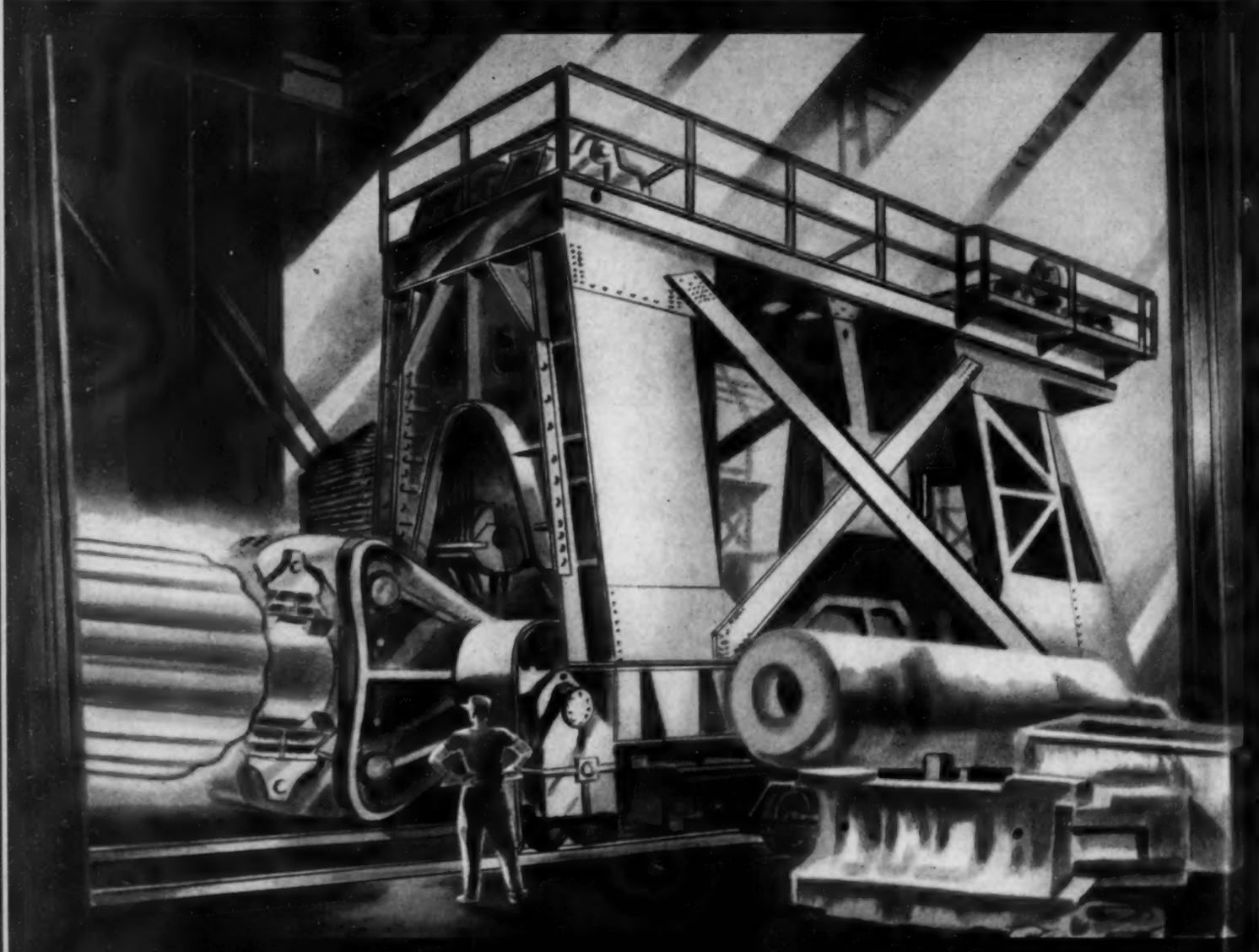
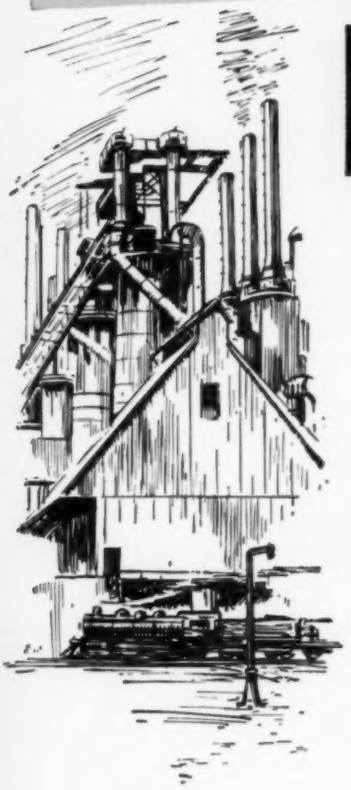
STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION · COKE PUSHERS

Give Us The Runway And We'll Lift The World



FOR MOST EFFECTIVE STEEL MILL LUBRICATION SYSTEMS

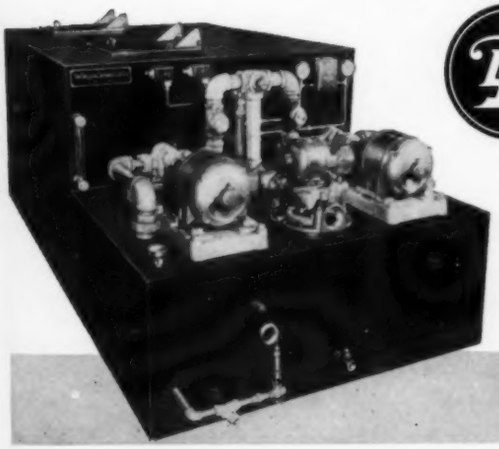


...DE LAVAL

De Laval lubrication systems for steel mills are all engineered to include four things:

1. **Correct Metering of Lubricant**
   De Laval Systems stress supplying each bearing and gear mesh point with exactly the right amount of lubricant. A constant streamline flow of lubricant in the correct quantity and pressure must be maintained at all times.
2. **Proper Selection of Pipe Size**
   The proper selection of pipe size is important to provide efficient lubrication. All De Laval Systems are designed to keep the pressure drop due to line friction at a minimum, and to insure a streamline flow.
3. **Efficient Temperature Control**
   De Laval Systems incorporate a constant control of the lubricant temperature both winter and summer. By the use of efficient heating or cooling facilities, a continuous flow of lubricant at the correct temperature and viscosity is maintained.
4. **Purification of Lubricating Oil**
   De Laval Oil Purifiers, furnished as part of the design where possible, are permanently piped to the system to permit centrifugal by-pass purification of the lubricant in service. The Purifiers remove water and fine solid contaminants.

The size of the mill does not matter. For large mills, De Laval designs "custom-built" systems; for small mills, a De Laval "Uni-Lube," self-contained unit with a circulating capacity up to 50 gpm, is available. ***Send for Bulletin 500.***



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Announcing the POWRWORKER "26"

Feature by feature, it's engineered to meet your own handling requirements

Detailed job-studies in customer plants, warehouses and terminals dictated the features of the POWRWORKER "26". No truck on the market today can match the POWRWORKER'S combination of *user-benefits*:

- **Maximum Maneuverability**—Only 26″ longer than the load, the shortest standard truck on the market.
- **Light Weight**—Completely fabricated construction combines maximum strength with least weight.
- **Stability**—Close-to-the-floor, low center of gravity.
- **Great Efficiency**—Double reduction of spur gears gives maximum ton-miles at least power cost.
- **Balanced Load Distribution**—Double lift cylinders for smooth lifting and lowering.
- **Safety**—Deadman switch cuts power when brake is applied, handle automatically returns to brake-position.
- **Easy to Service**—All operating units accessible without lifting or dismantling. Drive wheel tire is quickly demountable.

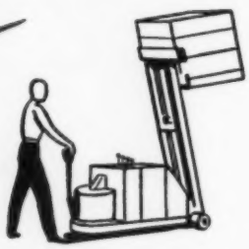
We invite you to compare the 1954 POWRWORKER with any truck on the market! For details, call your local Clark dealer, listed in the Yellow Pages. Or send the coupon for literature.

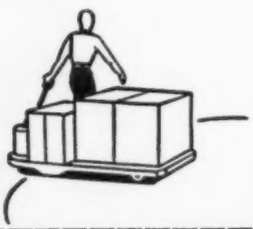
Ask your Clark dealer about Clark's low-cost Pay-As-You-Go leasing plan.

Pallet: 4000, 6000 lbs. cap.

Platform: 4000, 6000 lbs. cap.

Stacker: 1500, 2000, 2500. 3000 lbs. cap.





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Industrial Truck Division
CLARK EQUIPMENT COMPANY
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G.E. powers world's fastest rod mill

Co-ordinated General Electric drive system helps Jones and Laughlin produce rod at record-breaking 5000 fpm

The fastest Rod Mill in the world—Jones and Laughlin's Aliquippa, Pa. mill—produces high-quality steel rod at the record-breaking speed of 5000 fpm. Powered by a co-ordinated General Electric drive system, the new three-strand mill, placed in full operation last year, produces 26,000 tons of rod a month.

Design is a Joint Effort

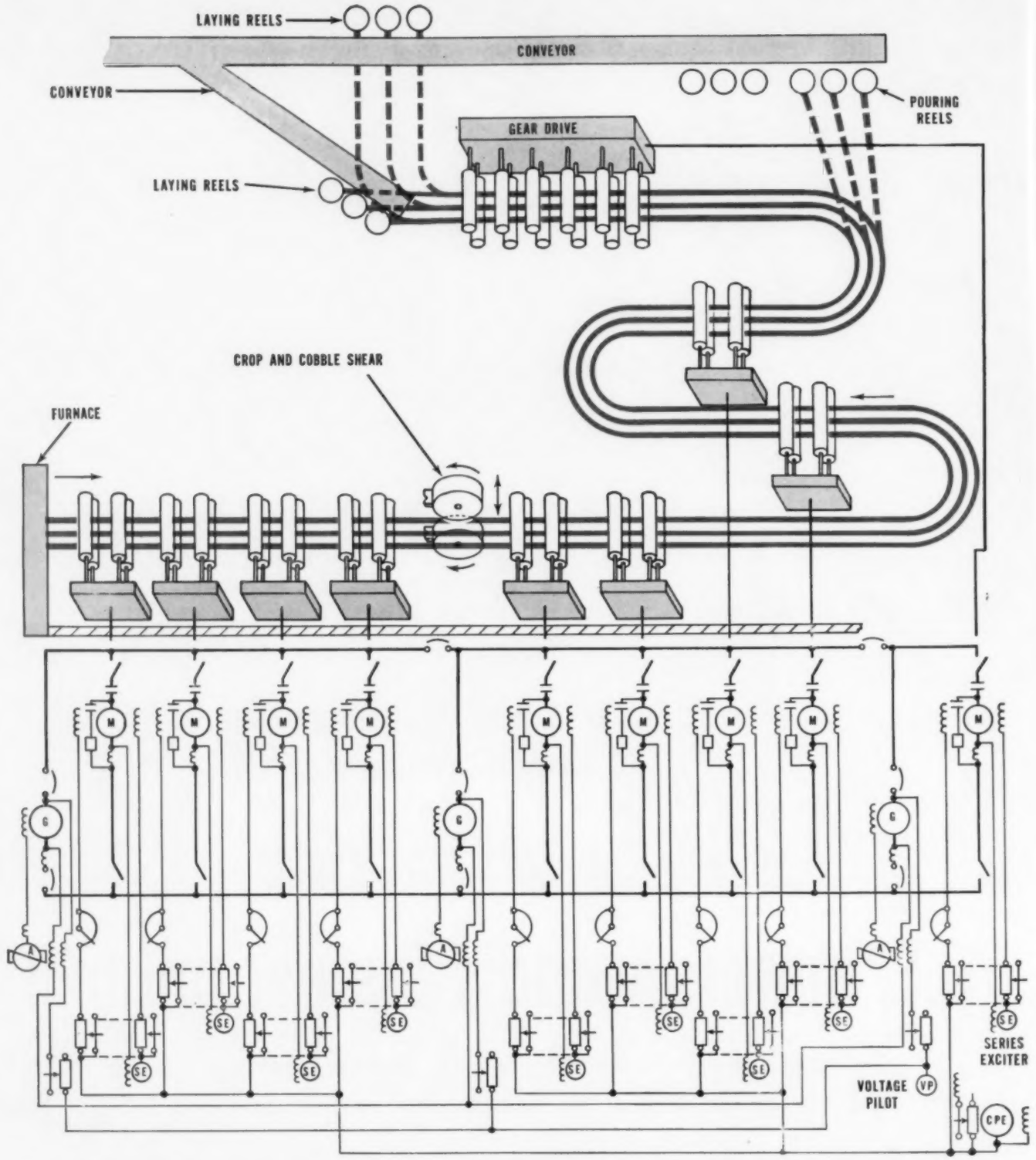
General Electric application engineers, working in close co-operation with United Engineering and Foundry Co. and J&L engineers, designed the 7200-hp main drive system. G-E field engineers assisted in the installation and start-up operations of the mill which was manufactured by United.

Modern Drives Increase Tonnage

The key to increased tonnage in today's mills is modern co-ordinated drives. Let G-E engineers help you plan your electrical system. They are specialists in the application, installation, and servicing of electric equipment for modern steel mills. Call in a G-E Apparatus Sales Representative—early in your planning General Electric Company, Schenectady 5, N. Y.

FOR ENGINEERING DETAILS, TURN PAGE ▶

GENERAL ELECTRIC



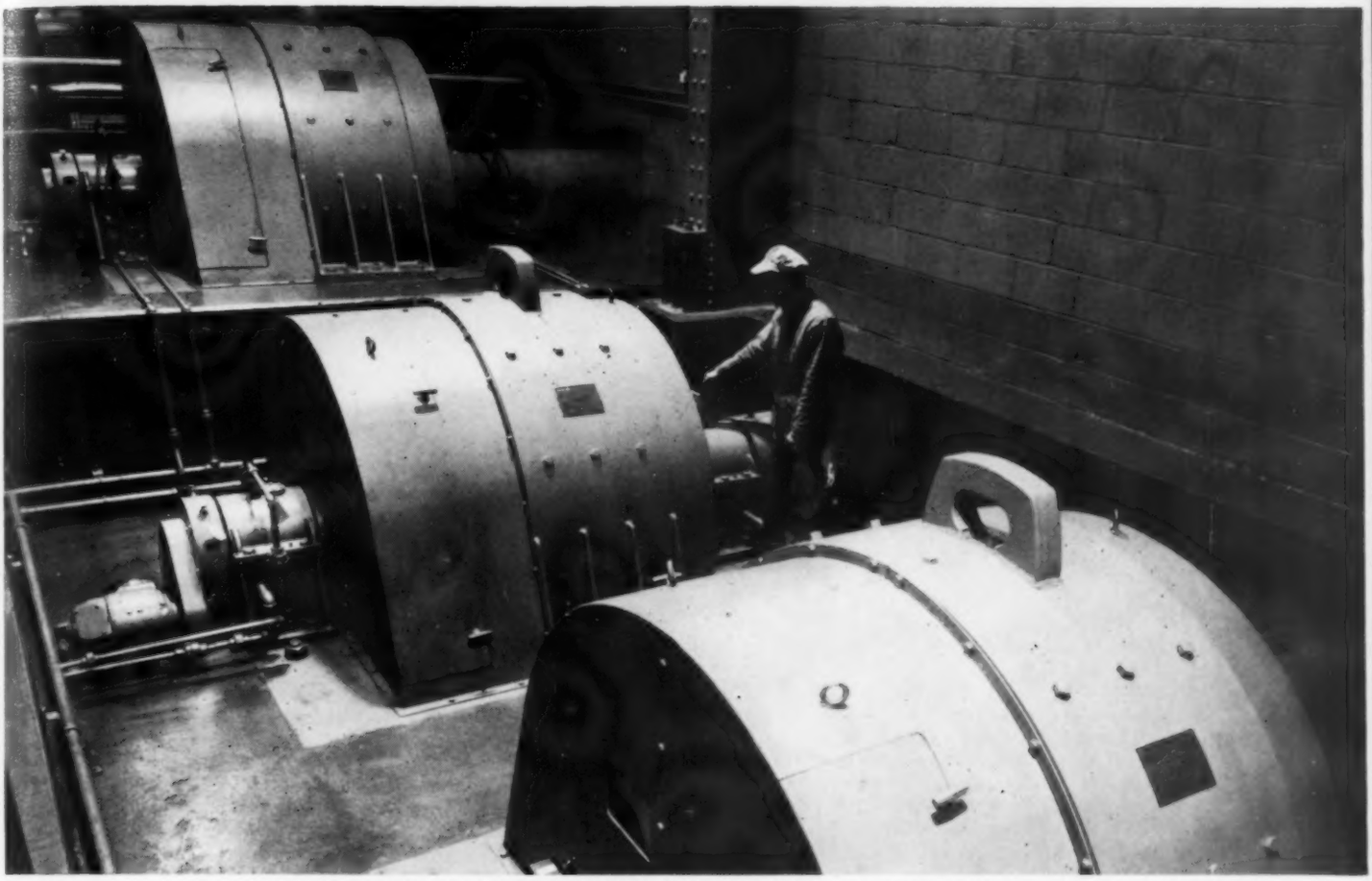
HOW THIS G-E DRIVE WORKS

This high-speed three-strand rod mill receives power from three generators—one 2250 kw and two 1500 kw, each feeding a bus section. They may be operated alone at different voltage levels, or in parallel to meet any rolling conditions. Amplidyne regulators accurately control voltage of each generator under steady-state and transient conditions. For parallel operations, amplidyne load balance between generators is connected automatically.

Nine mill motors ranging from 500 to 2000 hp deliver rod at speeds up to 5000 fpm. Low impact speed-drop characteristics of motors keep looping and stretching of rod at a minimum. Series exciters in motor auxiliary shunt fields help maintain low, steady-state speed regulation.

Adjustable voltage crop and cobble shear, pouring, and laying reel auxiliary G-E MD-600 drives are amplidyne controlled to follow speed changes in mill automatically. Rod as small as No. 4½ emit sufficient infrared light for direct operation of high-speed photoelectric relays for all relaying functions. Thus, strand indication, crop shear initiation, and rod switching are completely automatic. Complete co-ordination of main and auxiliary AC and DC control is included.

Another example of G-E Drive Engineering at work!



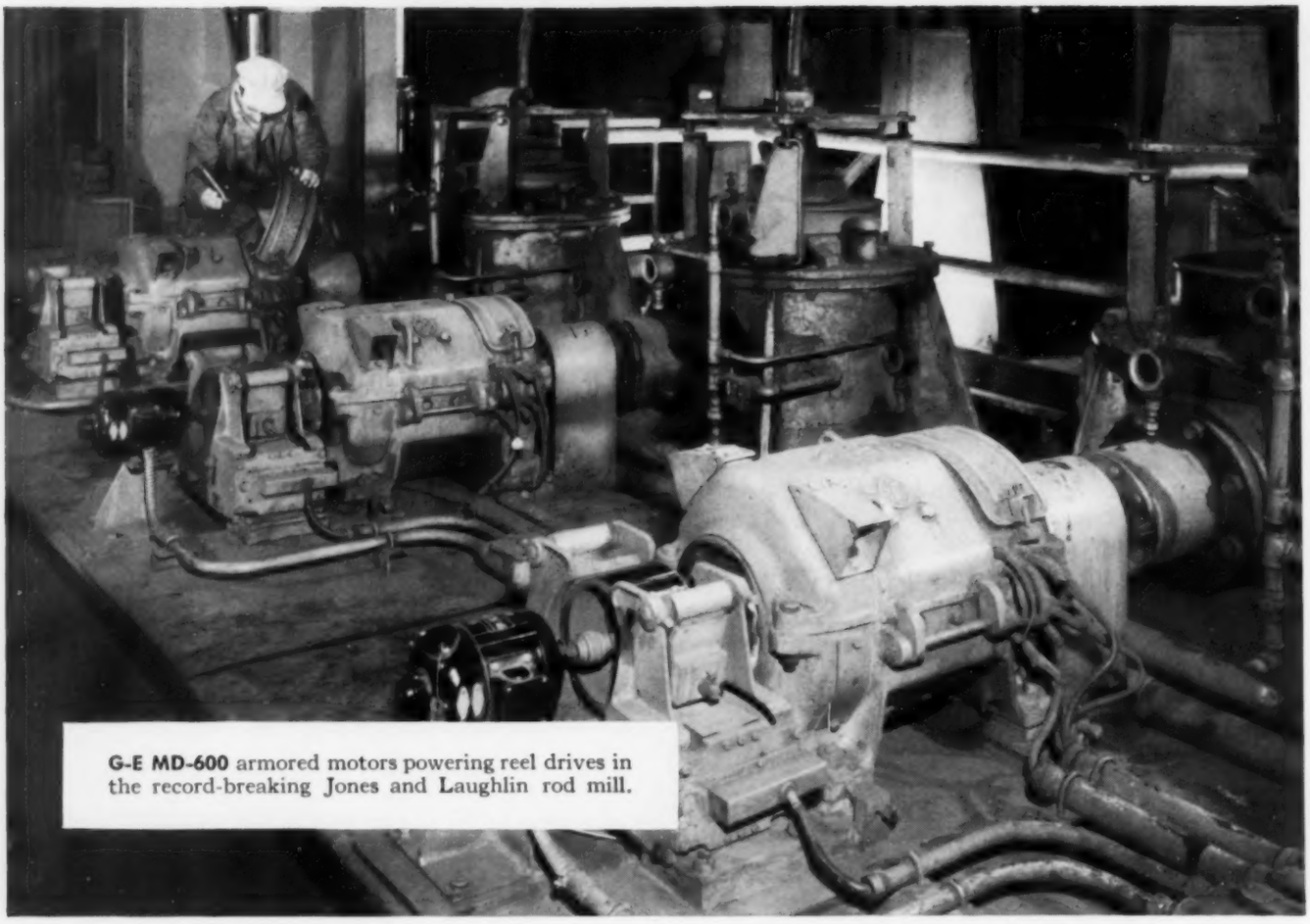
NINE GENERAL ELECTRIC D-C MOTORS RANGING FROM 500 TO 2000 HP POWER THE MILL'S 22 STANDS.

7200-hp G-E main drive system powers record-breaking J & L Rod Mill

ACCURATE CONTROL of pouring and laying reels is provided by this G-E control board. Amplidyne control assures low steady-state speed regulation of reels.

COMPACT, SPACE-SAVING G-E pumpless rectifier unit substation is easy to install. Located in motor room, it supplies d-c power to mill's auxiliary drives.

GENERAL ELECTRIC



G-E MD-600 armored motors powering reel drives in the record-breaking Jones and Laughlin rod mill.

G-E MD-600 motors help J & L step up production because . . .

Exclusive armature design of G-E armored motor allows quicker starts, stops, reversals!

The lower inertia of the MD-600 armature allows this motor to drive heavier loads, accelerate, start, stop and reverse quicker than ordinary mill motors.

G-E MD-600 armored motors start, stop and reverse quicker than ordinary mill motors because they have lower armature inertia (WK^2). For example, the MD-608 has 13% less than the next most popular mill motor.

WHY IS LOW ARMATURE INERTIA IMPORTANT TO YOU?

One important step to faster steel production is to cut manipulation time—which can take as much as half of your total production time. Manipulation time can be cut by reducing the total inertia of the machinery and auxiliary motors. Of this total inertia, your motors account for about 50%. The lower the armature inertia, the faster your motor will start, stop and reverse. The result—shorter manipulation time! By insisting on G-E MD-600 armored motors, you too can obtain faster steel production.

For more information contact your nearest G-E Apparatus Sales Office or write for a copy of Bulletin GEA-4654, Section 659-96, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

ALLEGHENY LUDLUM USES OKOLITE-OKOPRENE feeders for 70-ton arc furnaces

Cross section of 35 KV Okolite insulated power cable (⅔ actual size) which feeds arc furnaces at Allegheny Ludlum.

At the Brackenridge Plant of the Allegheny Ludlum Steel Corporation, two 70-ton and two 60-ton electric arc furnaces are equipped with Okolite-Okoprene rubber-insulated main power feeders. The cables are installed from overhead power feeders to the transformers and disconnect switches, and operate at 25,000 volts with peaks to 26,000 volts.

These single-conductor 750 MCM rubber-insulated cables with almost an inch (56/64″) Okolite rubber insulation and 8/64″ Okoprene sheath are rated at 35,000 volts, ungrounded. The installation at the Brackenridge Plant is another indication of the trend in industry toward the use of Okolite-Okoprene rubber-insulated cables for high voltage applications.

Okonite's new 128-page manual, Bulletin IS-1075, points out the advantages, versatility and economies obtained by the use of rubber-insulated cable for voltages up to 35,000 volts. Write for your copy to The Okonite Company, Passaic, New Jersey.

OKONITE OKONITE SINCE 1878 ***insulated cables***

2058

another TASIL "balanced" mixer lining sets new records for time in service and tonnage handled!

The 1000-ton hot-metal mixer of a major steel producer recently completed a 10-month campaign, handling 1,311,750 tons of iron. The mixer lining was "balanced" with Taylor Sillimanite (TASIL) Brick, laid in TASIL Cement, in the areas of severe erosion. Not a single brick was replaced nor any patching attempted during the campaign.

This sets a new mixer record, both for tonnage handled and continuous operation . . . and is the 9th *consecutive year* that TASIL "balanced" linings have been in service at this plant!

Let a Taylor field engineer give you full details on this proven TASIL application for mixers, ladles and hot-metal cars.

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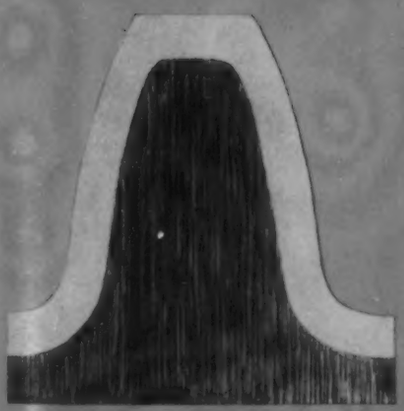
for guaranteed operating and maintenance savings

specify TSP gears and pinions

HERE'S WHY: "Tool Steel Process" gears and pinions are hardened by our special process. The file hard surface, to the full depth of permissible wear, gives *maximum life*. The core, refined for toughness and ductility, gives *maximum strength*. This combination gives TSP gears *maximum resistance* to fatigue. These are truly superior qualities found only in TSP gearing.

Made in all sizes to 80" pitch diameter, and in pitches from the heaviest to 10 D.P. Special designs made to your requirements.

You receive an absolutely positive written guarantee that TSP gears and pinions will give a longer life in the same service than any other product.



Section through TSP gear tooth, the gear of:

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2. MAXIMUM RESISTANCE TO STRESS AND FATIGUE
3. MAXIMUM CORE STRENGTH AND TOUGHNESS

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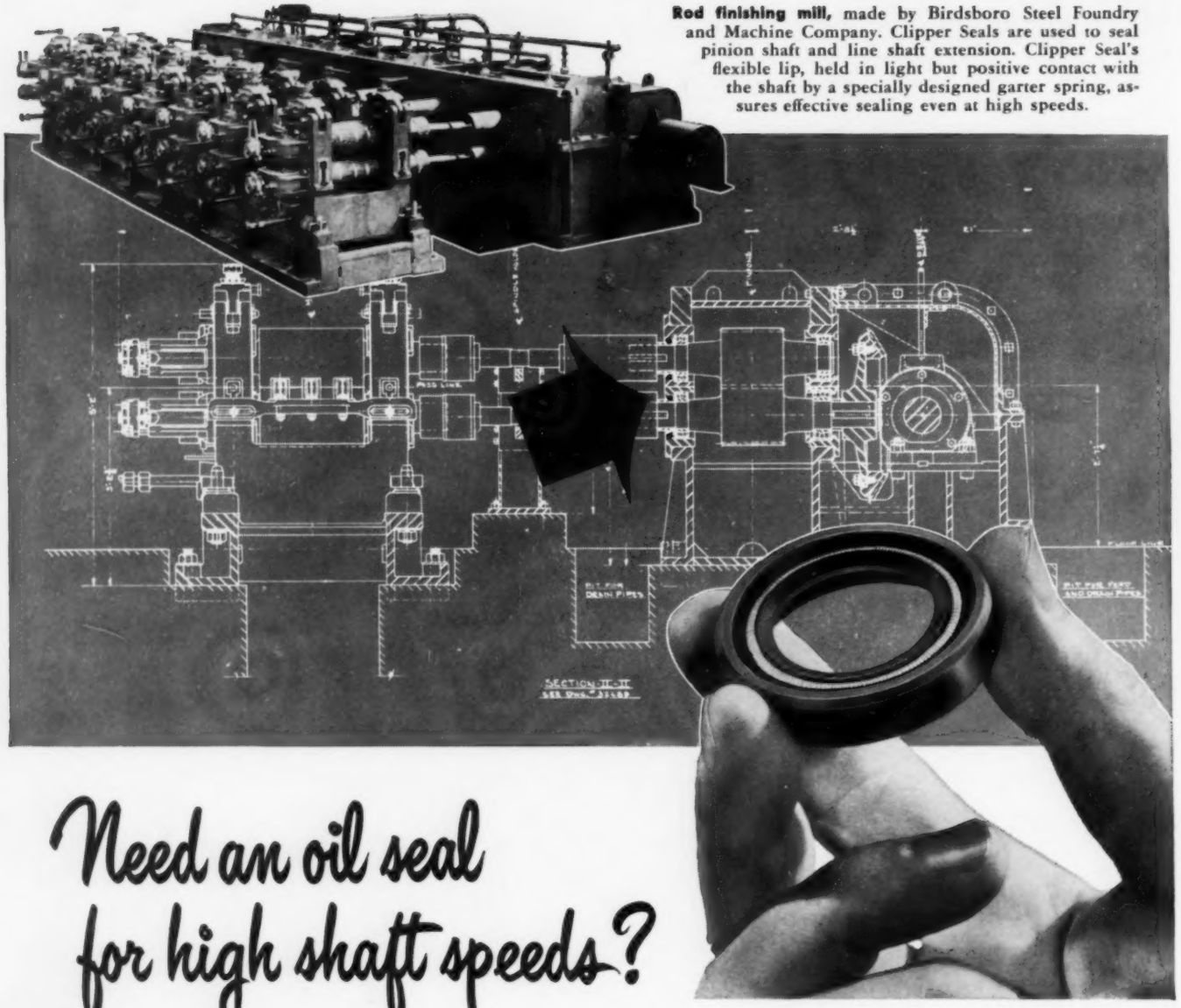


Rod finishing mill, made by Birdsboro Steel Foundry and Machine Company. Clipper Seals are used to seal pinion shaft and line shaft extension. Clipper Seal's flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, assures effective sealing even at high speeds.

Need an oil seal for high shaft speeds?

Birdsboro chose Clipper Seals

The Birdsboro 8-stand finishing train shown above is expected to operate around the clock, day in and day out. And since it is to be part of a large, high-speed, steel rod producing unit, Birdsboro designed it to be as maintenance-free as possible.

In order to minimize down time, particular attention was paid to bearing design and lubrication. The mill stands are equipped with open, water-lubricated bearings. Because of high shaft speeds, bearings in the combination spiral bevel gear reduction and pinion stand are anti-friction in type, lubricated with circulating oil, and sealed with Clipper Seals.

Birdsboro engineers chose Clipper Seals for this application because of their outstanding ability to withstand the heat of friction generated by high shaft speeds . . . and their ability to make a tight and lasting seal against the circulating bearing lubricant.

Still other reasons for Birdsboro's preference for Clipper Seals: They are precision-molded, compact in design, and exceptionally easy to install. They may be removed and replaced without impairing their sealing efficiency. And because of their unique design, Clipper Seals cause a minimum of shaft wear.

Precision-molded Clipper Seals are made in a variety of designs to meet almost any sealing condition. They are available in split and endless types, with a choice of heel and lip combinations for various services. For details, write for Brochure PK-46A. Address, Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

Set your own costs on DOWN TIME!

Shutting down one machine can shut down an entire department or mill. Downtime costs make the extra price of Ajax Dihedral Couplings insignificant. If you have misalignment troubles you can't afford to be without Ajax Dihedral Couplings.

AJAX DIHEDRAL FLEXIBLE COUPLINGS

Cross section shows exclusive design of Ajax Dihedral Couplings. They handle misalignment heretofore considered excessive. Backlash held to lubrication film requirements. Lubricant sealed in, dirt sealed out. All gear teeth hardened to 50-55 Rockwell C. Tell us your misalignment troubles.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.

Elliott FABRI-STEEL MOTORS AND GENERATORS

The stator of a 2000-hp, 64-rpm, 2300-volt synchronous motor for rotary rolling mill drive.

84-3

THE NO. 3 SEAMLESS TUBE MILL AT UNITED STATES STEEL'S NATIONAL TUBE DIVISION LORAIN WORKS is the world's largest producer of seamless pipe over 14-in. diameter and has made its mark as the greatest producer of transcontinental seamless pipe lines. This naturally involves top flight efficiency in all elements, and especially in the key units of driving motors. The pictures on these pages show some of the big, rugged Elliott motors that are helping to sustain this high production record.

...ELLIOTT MOTORS

But there is more to the story. In converting the mill from 25-cycle to 60-cycle power, these 60-cycle motors were required to fit existing bearings and bases used by former 25-cycle driving units, thus imposing a limiting design factor. All the motors met this requirement with uniform success, fitting into place within the scheduled short periods of mill downtime, and thus maintaining production with the minimum possible interruption — a noteworthy achievement of Elliott engineering.

Full details on these and other Elliott motors are available from your local Elliott representative, or write direct to Elliott Company, Ridgway Division, Ridgway, Pa.

ELLIOTT Company

COMPRESSORS

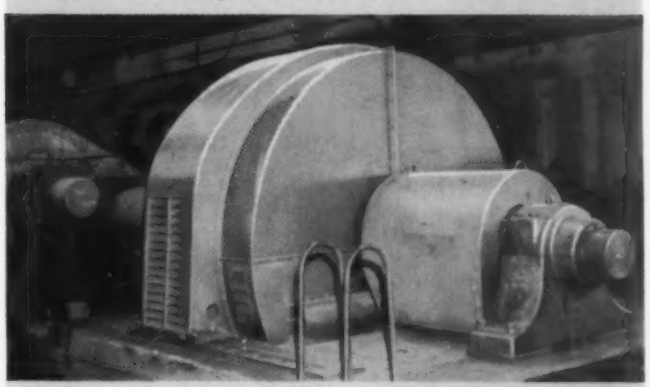
TURBOCHARGERS

TUBE CLEANERS

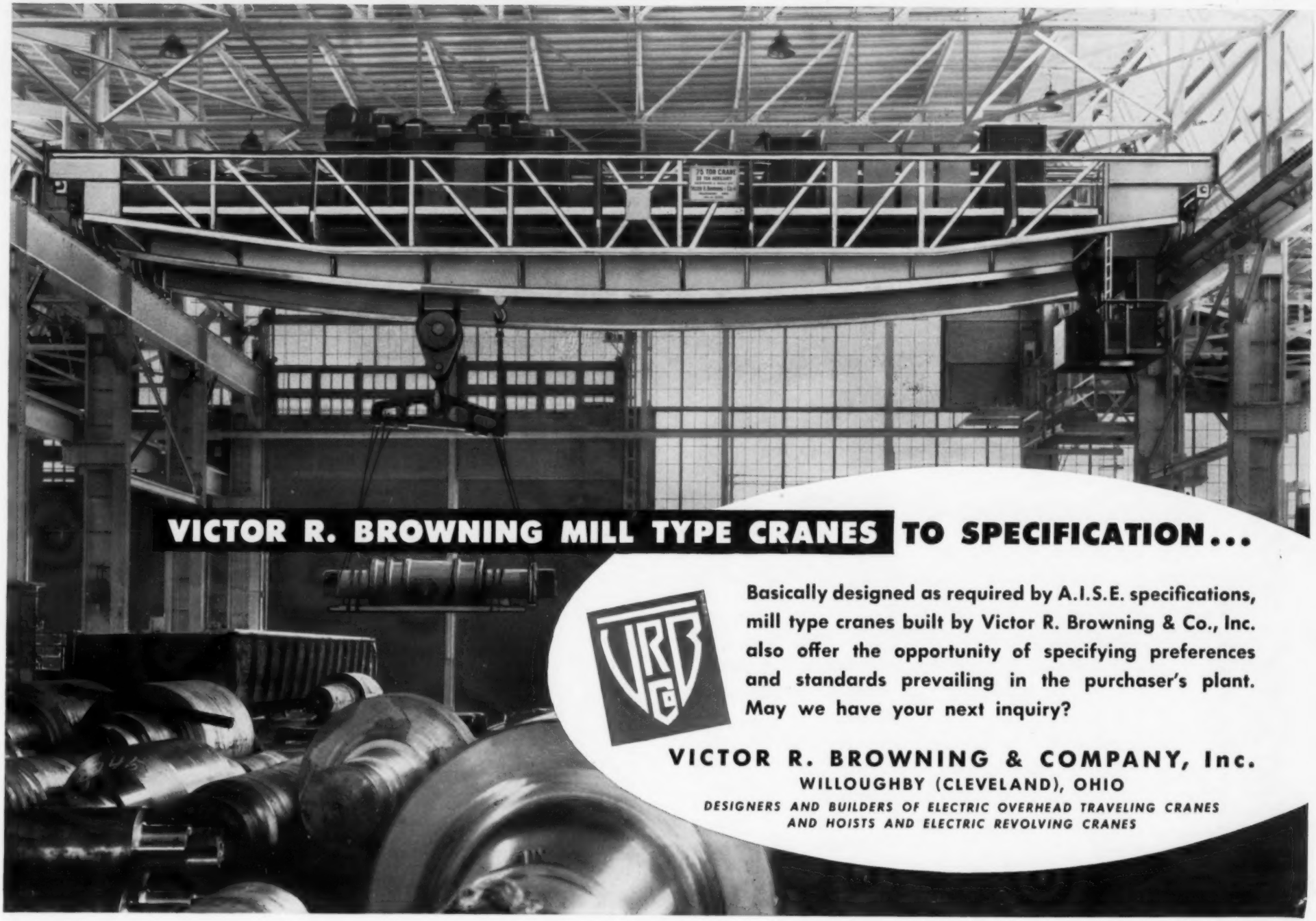
STRAINERS

The East reeler, showing one of two Elliott motors driving reelers. The motors are 600-hp, 380-rpm, squirrel-cage induction motors.

An Elliott 3500-hp, 514-rpm, 13,800-volt synchronous motor driving a d-c generator. Typical of another 2100-hp synchronous motor of similar characteristics supplied for d-c generator drive.


One of two Elliott 5000-hp, 257-rpm, 13,800-volt synchronous motors driving piercing mills.

The completed motor, of which the stator is shown opposite, installed on the driving end of a rotary rolling mill.



VICTOR R. BROWNING MILL TYPE CRANES TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

WILLOUGHBY (CLEVELAND), OHIO

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

This bronze screw-down nut weighs 12,000 pounds

Cast by NBD for use on 144-inch plate mill

Two of these giant screw-down nuts were required for a 144-inch rolling mill. Each had to be cast to exacting specifications and machined to close tolerances.

Cast from super-strength manganese bronze, they required approximately 20,000 lbs. of metal to pour. Dimensions, before machining, were 43 inches outside diameter by 38 inches high. All rough machining was done in the Meadville Plant of National Bearing.

Jobs such as this move accomplishment out of the arena of mere claims. The skill, experience and willingness to pioneer, shown here, are proof of real founding ability.

If your products require precision-cast bronze, or other copper-base components, it will pay you to investigate the facilities of National Bearing Div. Ask to have a sales engineer call. Write National Bearing Division, 4930 Manchester Ave., St. Louis 10, Missouri.

AMERICAN Brake Shoe COMPANY

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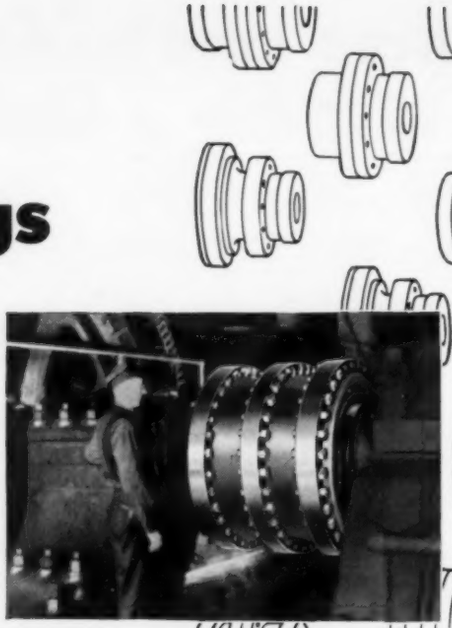
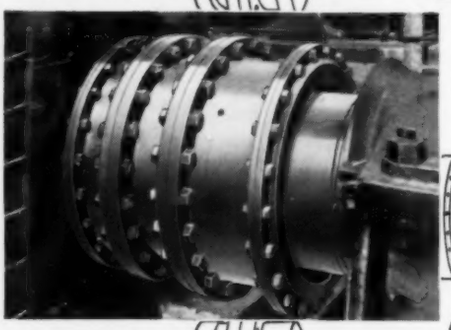


Fast's Coupling installation in a leading steel production plant.



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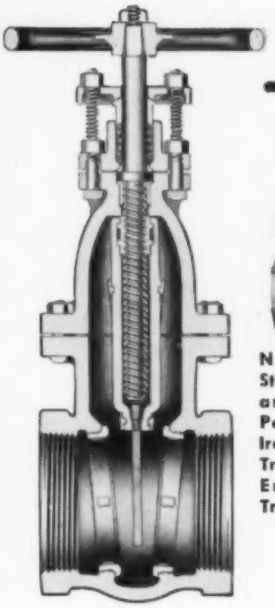

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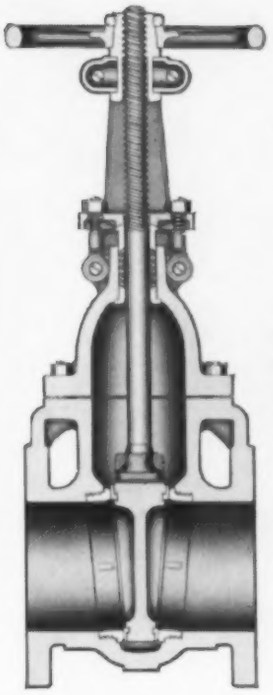

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Crops and Shorts

IRON ore production in the United States in 1953 totaled 119,200,000 tons, divided between the various districts as follows:

	Tons
Lake Superior	96,100,000
South-eastern	7,600,000
North-eastern	6,600,000
Western	8,900,000
Undistributed (by-product)	600,000

In addition, 11,085,085 tons of iron ore were imported, of which 55 per cent came from eight Latin American countries, 17 per cent from Canada, 19 per cent from Europe, and 9 per cent from Africa.

Exports in 1953 totaled 4,251,365 tons, of which 3,853,580 tons went to Canada and the remainder to Japan.

The consumption of iron ore, magniferous iron ore and sinter by the iron and steel furnaces of the United States averaged 389,102 tons per day during 1953.

▲

WE don't know how you feel about it, but we're getting awfully fed up with daily front page stories about Senator McCarthy and current heart interests of Aly Kahn and other international playboys. Perhaps newspapers should worry less about freedom of the press and think more about their poor readers.

▲

C. M. WHITE, president of Republic Steel Corp., told an audience of Cleveland business men: "We have made up our minds that we have got to spend more money to put steel into new forms. We're going to double what we had planned to spend this year."

▲

PSYCHOLOGISTS say no person should keep too much to himself. A friend of ours says the Bureau of Internal Revenue is certainly of the same opinion.

▲

INTEREST in electric arc furnaces continues to grow. Two major steel producers who have no electric furnace capacity at present are considering the installation of some large units.

THE practice of selling merchandise at a discount, as carried on by some merchants and as bemoaned by others, is really spreading. Word from San Francisco has it that discount funeral parlors will soon be operating there.

▲

ACCORDING to figures from the Business and Defense Services Administration, world steel production set a record in 1953 at 254,700,000 tons of ingots. Of this, 79 per cent, or 200,900,000 tons, was made by free world countries, and 21 per cent, or 53,800,000 tons, by Iron Curtain countries. Russian production is estimated at 40,000,000 tons.

▲

A person's viewpoint certainly depends on age. When a Hollywood actor, aged 10, was cast in a movie with Marilyn Monroe, he said "Good! Now I can get DiMaggio's autograph."

▲

EVERY once in a while someone coins a new word that more or less catches popular fancy and is promptly worked to death. The most recent one seems to be "automation," which many people seem to think is a new idea. If there is such a thing as automation (which Webster's unabridged dictionary apparently denies), it is certainly not new, but started when some prehistoric genius invented the wheel and the lever, and continued down through the myriad inventions and developments of the centuries. True, recent strides in electronics have given great impetus to automatization, but let's not go overboard and think that a new science has been discovered.

▲

WE'VE always heard that he who dances must pay the piper, but what about the waiter, the florist, the hat-check girl, the doorman and the parking attendant?

▲

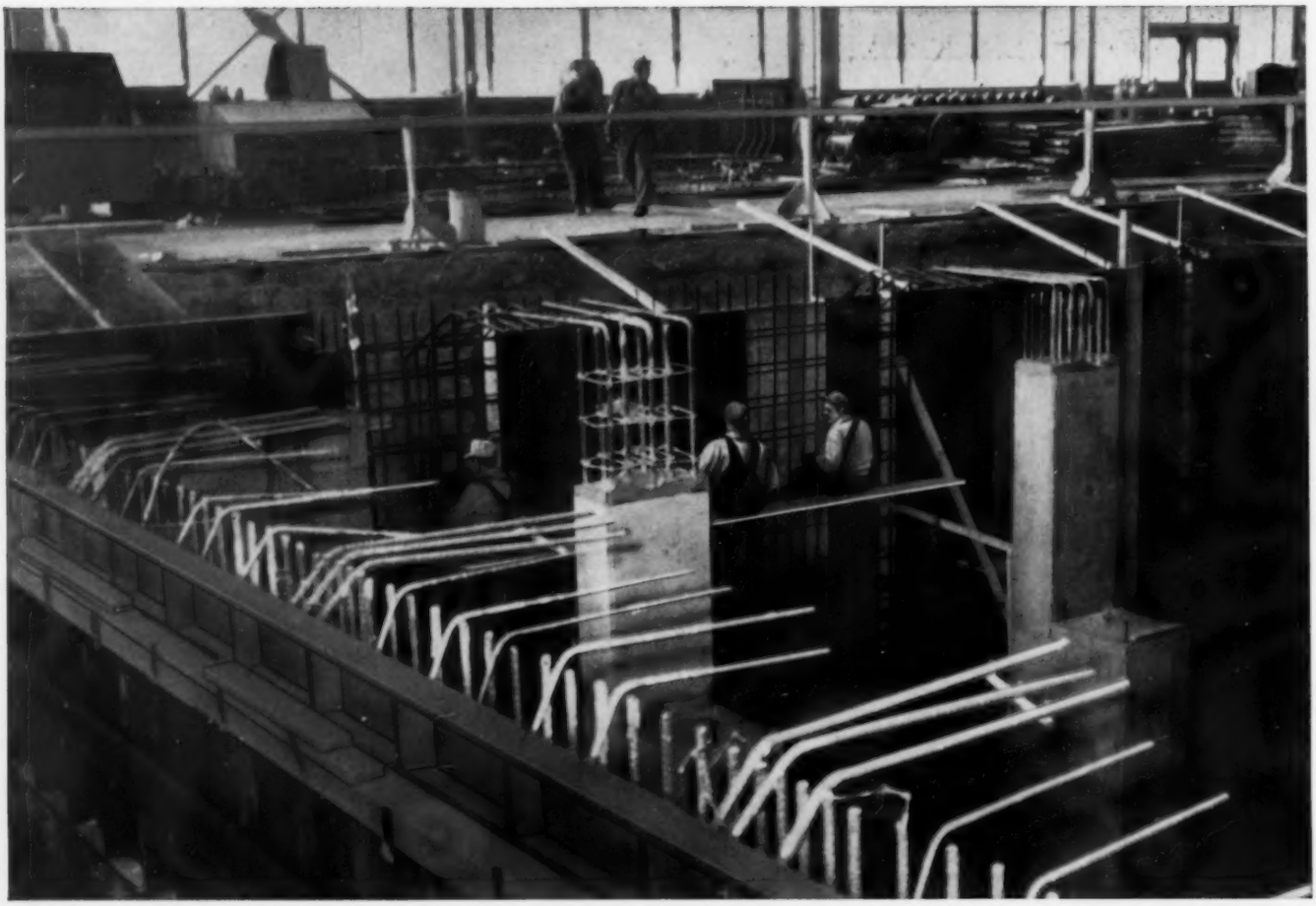
UNITED States Steel Corp. has 286,240 stockholders — almost as many as their employees. Their holdings average approximately $8000 each, and more than half (53 per cent) have total annual incomes smaller than the average steel worker's income. It is interesting to note that 37 per cent of the company is owned by people with incomes under $5000 per year, 33 per cent by people with incomes between $5000 and $25,000 per year, and 30 per cent by people with incomes over $25,000 per year.

▲

A correspondent tells us it's easy to spot a well-informed, sensible man. His views coincide with yours.

▲

FIGURES from the American Iron and Steel Institute show a production of stainless steel for 1953 of 1,015,303 tons, an all-time high, made by 20 producers. The drop in stainless consumption by the aviation industry and government business was made up by wider use in other industries.



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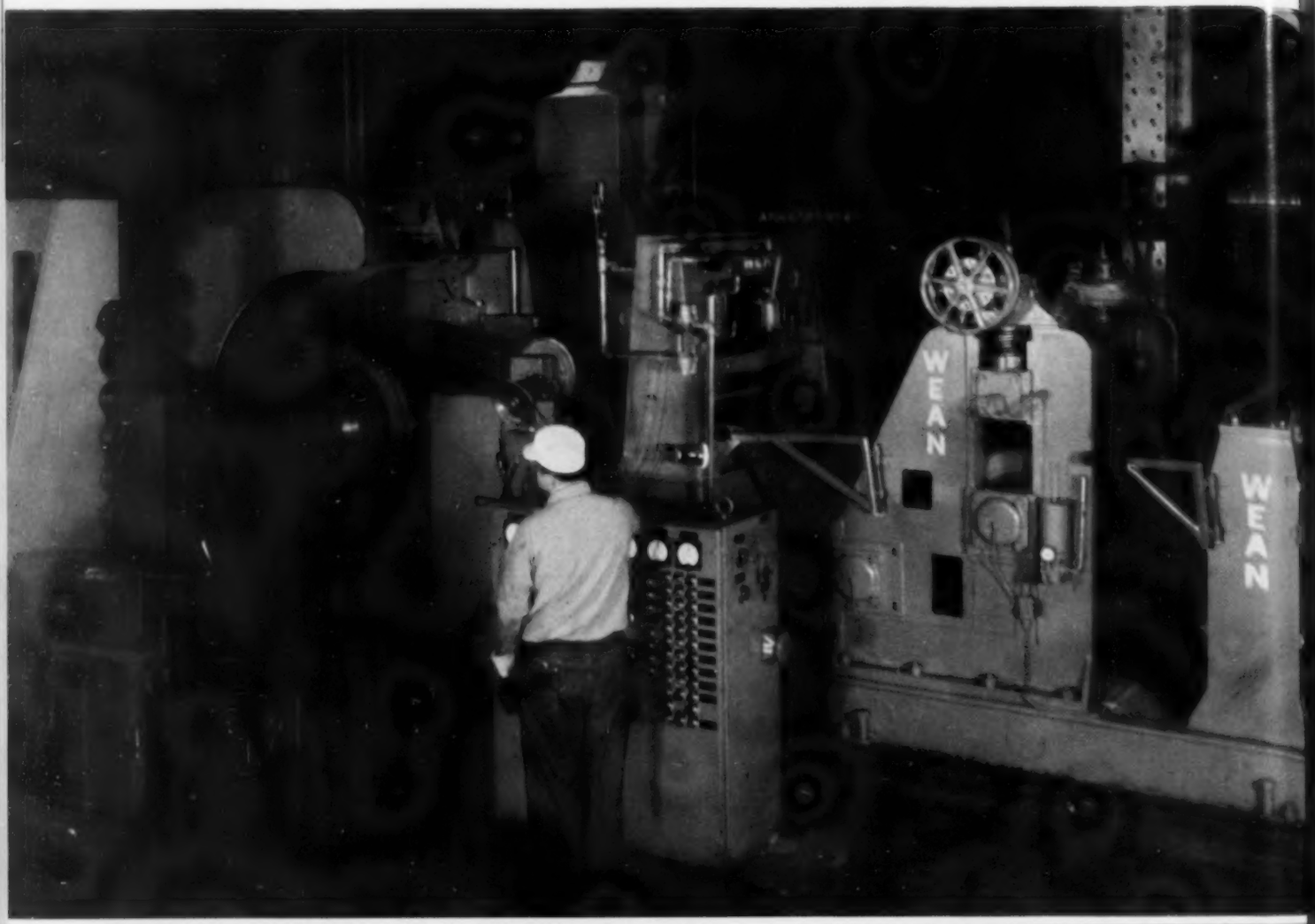

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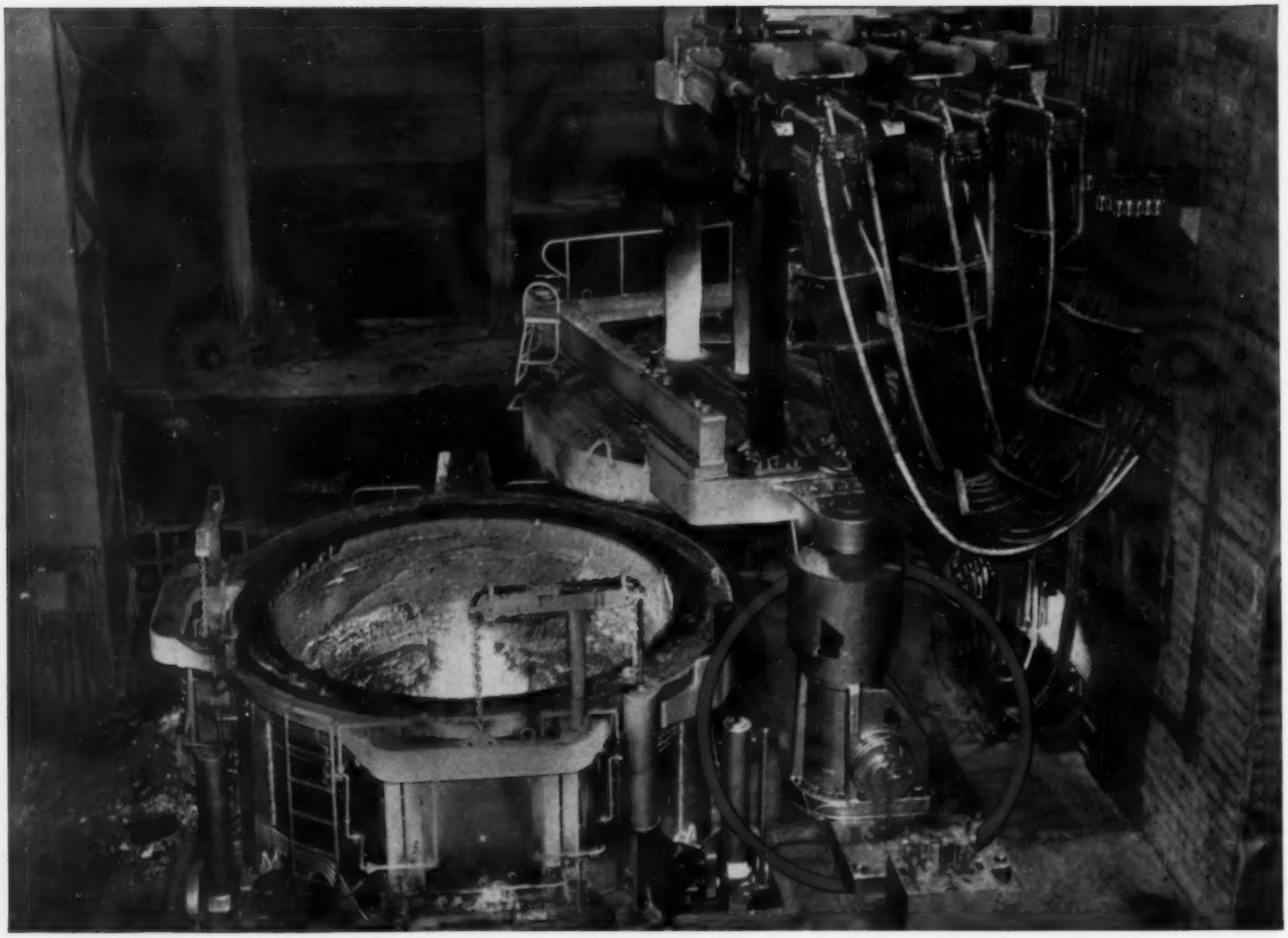

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

UNITED STATES STEEL IN THE WEST

. . . . in twenty-three years, U. S. Steel increased its ingot capacity west of the Mississippi more than six times . . . .

By JOHN L. YOUNG
Vice President — Engineering
United States Steel Corp.
Pittsburgh, Pa.

▲ RECENTLY, an article in the Monthly Review of the Federal Reserve Bank of San Francisco gave a rather comprehensive picture of western steel. The article was called "Twelfth District Steel: A War Baby Grows Up." "The far western steel industry," stated the Review, "was a war baby launched to supply steel for Pacific Coast shipbuilding." But the infant has achieved maturity within a decade. It has grown about 400 per cent since 1943, and it now fills nearly two-thirds of the demand for steel products in the seven states of the Twelfth District.

The Review went on to say that even in the years since 1947, the district's capacity to produce steel has expanded at a rate exceeding the growth rate of the nation's steel industry as a whole. Tin plate production —especially needed in the West because of the vast canning industry—has been expanded greatly since 1945. When full production is reached, the district's mills will turn out about 60 per cent of the current West Coast demand for tin plate. Other conversion facilities have been increased proportionately. Pipe and tube capacity, for instance, has increased almost seven times and hot rolled strip capacity about ten times.

Official figures verify the statement that the growth rate of the fifteen state AISI district since 1947 has exceeded that of the nation. Total U. S. capacity has increased 36.3 per cent in the last seven years, while that of five western steel producing states of the fifteen in the district has increased 45.1 per cent.

That is the general picture. It is certainly one of which the West can be proud. Those of us who are with United States Steel divisions or associated subsidiaries are proud of our participation in this great expansion.

United States Steel has grown with the West until we now have six divisions operating out here. The following outlines briefly what they are, and how they serve the West.

COLUMBIA-GENEVA

History has shown repeatedly that great enterprises often begin in a small way. Certainly this fact is borne out in the case of the Columbia-Geneva Division. The history of that division begins in 1909, with a small foundry in Portland, Ore., manufacturing steel castings for use in the logging, lumber, and gold dredging industries. The manager of the foundry was a man named Charles M. Gunn. Realizing that steel was essential to the continued growth of the industries his company served, Gunn began enlarging the Columbia steel facilities at that time.

It is interesting to note in passing that since the company had been organized under the laws of Nevada, the directors were required to take that state's official oath. One of its provisions stated that the directors must be persons who "never had been nor ever in the future would be involved in a duel in any capacity." Such was the official attitude at that time to the all too frequent use of the six-shooters as a means of arbitrating business disputes. At any rate, Gunn (perhaps in spite of his surname) was elected first president of Columbia. In that same year, Columbia acquired some 19 acres of property in Contra Costa County, about 45 miles east of San Francisco. The property was situated in the town of Black Diamond which later was renamed Pittsburg (but without the "h," not having been a fort).

A new foundry was completed at this site a year later, and in 1916 the company, now under the direction of Wiggington E. Creed, added a 5-ton acid open hearth to provide the steel necessary to meet the constantly increasing demand for castings.

When the United States entered World War I, Columbia Steel was ready to supply armament steel—the Pittsburg and Portland foundries worked round the clock producing castings for war vessels "laid down" in West Coast shipyards.

In 1918, a 23-ton basic open hearth furnace was added at Pittsburg, and following the war, in 1920, a roughing mill and a merchant mill also were added. The year 1922 marked an important forward step in Columbia's growth when a 450-ton blast furnace and a battery of by-product coke ovens were built at Ironton, near Provo, Utah. The new blast furnace—the first West of the Rockies—was blown in April 30, 1924. In the meantime, further expansion of the open hearth facilities

had taken place at Pittsburg. In 1923, two 50-ton basic open hearths were put in operation, and a rod mill, a wire and nail mill, and a sheet mill were added. These mills were the first of their kind west of the Mississippi.

At that time, the Torrance plant consisted of two 40-ton open hearths, a combination roughing and finishing mill, two merchant mills, and a steel foundry. Further improvements included the addition of two open hearth furnaces and improved rolling mill facilities. Additional facilities were added in 1926.

The year 1926 was an important one at Pittsburg. A tin plate mill (the first of its kind west of the Mississippi) and two 75-ton basic open hearths were added at that time.

UNITED STATES STEEL PRODUCTS DIVISION

The United States Steel Products Division on the coast dates back to 1939. This division has two plants, one in Los Angeles producing steel drums and a complete line of galvanized ware, garden tools, wheelbarrows, oil and gasoline cans and houseware items, and another plant in Alameda manufacturing steel drums and pails. The two plants serve seven western states.

UNITED STATES STEEL SUPPLY DIVISION

The United States Steel Supply Division is a relative newcomer to the West Coast. Prior to 1947, this division, which is the warehouse outlet for United States Steel, had operations in 10 principal industrial areas east of the Rocky Mountains.

In January of that year, it expanded its facilities by opening a warehouse in Los Angeles. Early in 1948, an additional facility was started in San Francisco, followed in the same year by two other operations in Portland, Ore., and Seattle, Wash.

With these four plants on the West Coast, and another in Houston, Tex., the supply division organization expanded its service to steel warehouse customers to provide virtually border-to-border and coast-to-coast distribution outlets for users of steel in relatively small amounts.

The finished steel stocked in inventory by the supply division represents a wide variety of types and grades, manufactured principally by the producing units of United States Steel.

In addition to operating as a general store of steel products, providing an easy and ready source of supply to big and small steel users for their immediate requirements, these units also are equipped with machinery for flame cutting, sawing, and shearing steel to the specifications of West Coast customers.

OIL WELL SUPPLY DIVISION

Oil production was well established in California by the turn of the century. As discovery, development, and production of oil progressed, oil well stores were established in all active areas of the Southwest and West. Between 1900 and 1910, supply stores were opened in California at Los Angeles, Taft and Bakersfield.

"Oilwell's" first machine shop was started in 1905 at Coalinga. The Los Angeles manufacturing plant and shop was built in 1908. The Taft shop opened in 1912. Following the discovery of oil in 1921 at Huntington Beach, Long Beach, and Santa Fe Springs, new field stores were opened in locations most suitable for serving this new section of the industry.

Today, "Oilwell" has a total of eleven stores in California, and a new headquarters office, warehouse and shop building, built in 1952, in Los Angeles. During the last three years, the Long Beach, Bakersfield and Ventura stores have been enlarged and modernized, and in 1952 the Castaic Junction, Calif., store was opened.

GERRARD STEEL STRAPPING DIVISION

Another division of U. S. Steel operating on the west coast is the Gerrard Steel Strapping Division. Many operators are acquainted with the ingenious devices for wire and flat band tying of all sorts of packages, bundles, boxes, crates, and even carloads of material.

Branch offices and service shops are located in Los Angeles, San Francisco, Portland, and Seattle.

CONSOLIDATED WESTERN STEEL DIVISION

This division began as a fabricator of pipe for the hydraulic gold mining industry a century ago. In the intervening years, the activities of this enterprise expanded greatly. The fabrication of structural steel, elevators and boilers, and equipment for the mining and oil industries were gradually added to its functions. The scattered activities of the organization were first centralized in 1930 in the Los Angeles area at Maywood on an original 50-acre tract of land.

Consolidated first came into national prominence in 1932 when it fabricated and erected the massive butterfly valves for the Hoover Dam and 85 per cent of the towers to carry power lines from the dam to Los Angeles.

Another noteworthy achievement was its participation in the shipbuilding program of the U. S. Maritime Commission in 1940. Although 22 miles from the sea, the Maywood plant fabricated huge steel sections which were trucked to the Craig Yard at Long Beach for assembly. Other shipyards were later opened at Orange, Tex., and Wilmington, Calif.

During the war, the Maywood plant also fabricated and machined precision war materials. By 1943 more than one-third of all Maywood personnel had been transferred to the Consolidated Naval Ordnance Division for production of anti-aircraft guns for the U. S. Bureau of Ordnance.

The home office and centralized plant is still in Maywood. Another large California plant of Consolidated is at South San Francisco. These plants, along with smaller ones at Berkeley, Vernon, Fresno and several other places furnish complete services for fabrication and erection of structural steel, pipe and plate products, mechanical equipment and perform machine work. These services are available to overseas customers as well as west coast customers.

The foregoing has covered briefly the divisions form-

ing the diversified U. S. Steel family in the West. The following paper by W. F. Pruden will cover the more recent developments of the Columbia-Geneva division.

By W. F. PRUDEN
Chief Engineer
Columbia-Geneva Steel Div.
United States Steel Corp.
San Francisco, Calif.

▲ UNITED States Steel began its steel producing operations in the West in February, 1930 with plants at Provo, Utah, and at Torrance and Pittsburg, in California. At Provo, Utah, there was one blast furnace rated at 175,000 tons per year, serviced with coal and ore from mines in central and southern Utah. Much of the pig iron produced at Provo was shipped to California, where it was charged with steel scrap in the eleven open hearth furnaces there—four of them at Torrance, in the Los Angeles area, and seven at Pittsburg in the San Francisco Bay area.

At that time, Torrance also had one electric furnace, a steel foundry, a 36-in. blooming mill, a 22-in. sheet bar and structural finishing mill, 12-in. merchant mill, and a sheet mill including sheet galvanizing facilities. In addition to the open hearth shop and foundry at Pittsburg in 1930, there was a small rolling mill, a rod mill, a sheet and tin mill, and a wire mill. A small foundry in Portland is also in operation.

In 1932, United States Steel entered the wire rope manufacturing business in San Francisco. One of the primary products of this operation was wire rope for the San Francisco cable cars. In 1941, most of the equipment was relocated to the Columbia plant at Pittsburg, Calif. New high speed stranders, stranderlayers, spooling and re-reeling equipment were purchased and installed in new buildings. This same equipment is currently turning out aircraft control cable, oil rig cable, clothes line strand, and wire rope for many other modern day uses. Also the old horizontal layer originally built in the 1880's is today still turning out at Pittsburg Works the wire rope required for San Francisco's present cable cars!

During the years 1941, 1942, and 1943, the output of the Pittsburg Works for finished wire products was further increased. This expansion started at the open hearth shop with the addition of a new 90-ton furnace. The rolling mills were adapted to produce 30-ft billet lengths, and an entire new continuous type 21-stand, 3-strand rod mill was built. This rod mill was the first of its kind to be installed in the Western states. New wire drawing machines and nail cutting machines were added, along with wire galvanizing equipment and accessory facilities. This expansion program required substantial rearrangements and improvements in the plant layout and utility systems, which are significant parts of the present modern plant at Pittsburg.

To give a more complete picture of United States Steel's activities after World War II, one should go back to the beginning of the steel plant at Geneva, Utah. Columbia Steel Co., the steel producing West Coast subsidiary of United States Steel, was assigned by the government to the task of directing the design, construction, and operation of the Geneva plant. Ground was broken in April, 1942, on the 1500-acre site in Utah Valley. The name "Geneva" given to the steel plant comes from a Utah lakeshore resort formerly operated near the present site of the plant. The original owner, who was of Swiss ancestry, named the resort "Geneva" because the surroundings so resembled his native Switzerland.

The Geneva plant has been described as the engineer's dream! It is one of the few completely integrated steel plants constructed as a single project and is still one of the most modern plants in the world. The original facilities included 252 coke ovens arranged in four batteries, three 1120-ton blast furnaces, nine 225-ton basic open hearth furnaces, six two-hole batteries of soaking pits, a 45-in. reversing two-high slabbing and blooming mill, a 132-in. four-high semi-continuous plate mill, and a 26-in. structural mill.

The blooming and slabbing mill is a 45 by 115-in. two-high reversing mill powered by twin motor drive. The mill rolls ingots 29 by 66 in. in cross section weighing 40,000 pounds each, into slabs or blooms for the plate or structural mill. The original plate mill rolling equipment consisted essentially of a two-high scale breaker, a four-high non-reversing broadside mill, a four-high reversing rougher equipped with edging rolls, a crop shear, a two-high scale breaker, and four four-high continuous finishing stands. The roughing stand in the 132-in. mill is driven by a single 7000-hp reversible motor, one of the largest of its kind ever built, which drives top and bottom rolls through a pinion stand. Each of the finishing stands is powered by an individual 5000-hp motor.

Plates and structural shapes for shipbuilding were the principal finished products planned for this mill for wartime operation. In the months following V-J Day, thinking turned to conversion for peacetime production. There was great interest in the West in seeing this plant continue to operate to serve the post-war era of industrial expansion.

Beginning in 1946, United States Steel undertook the conversion of the Geneva plant to more adequately serve the requirements of a peacetime economy. This conversion program included modifications and additions to the equipment to adapt it for an annual production capacity of more than one million tons of hot rolled wide strip coils and plate products. The major items added to the 132-in. mill included a slab squeezer, a vertical edger, two additional finishing stands, two downcoilers, and a conveyor system from the downcoilers to a new coil storage building.

The two additional four-high 132-in. finishing stands were added beyond the existing four stands to provide a train of six four-high continuous finishing stands. With these additional stands, the desired reduction for the rolling of hot strip was obtained, and the delivery speed was increased to approximately 2000 fpm. The added stands are also utilized during the rolling of plate products.

Two hot strip cage-type downcoilers were installed at the end of the mill runout table beyond the plate transfer. These units are designed to receive hot rolled strip in coils up to 72 in. wide, having a maximum outside diameter of 52 in. A coil conveyor system was also provided, having a capacity of approximately eighty coils per hour, which extends from the downcoilers into the coil storage building. We believe that our Geneva 132-in. mill is unique in its ability to produce such a wide range of products from 24-in. strip in coils to 120-in. wide plate, through the same finishing stands.

Since completion of the conversion immediately following the war, other facility additions have been made also at Geneva, including a tenth open hearth furnace, and a hot rolled sheet shearing line. Today Geneva has an ingot capacity of nearly 1,900,000 tons.

sheets to the long list of products manufactured by this division.

These new production units that we added to the Columbia plant in 1948 included the five-stand cold reduction mill, continuous pickling and electrolytic cleaning lines, temper mills, a galvanizing line, fourteen hot dip tinning lines, an electrolytic tinning line—another first in the West—and sixteen mechanical assorting, reckoning, and piling lines for tin plate. At the same time a complete metallurgical laboratory to insure proper quality control in the processing of these highly specialized products was built. It contains all of the latest instruments and equipment developed for such purposes.

It was soon evident that additional capacity for flat rolled products would be required, and in 1953, had

Figure 1 — Practically all U. S. Steel's productive activities in the west are carried out west of the Rocky Mountains.

Now part of the plan for the conversion of the Geneva facilities was to provide a source of semi-finished coils which could be shipped to a new, modern sheet and tin mill on the West Coast. This new flat rolled finishing facility was installed at the Pittsburg, Calif., Works. In 1948 the first cold reduction mill in the West was put in operation. This added cold reduced steel as well as cold reduced tin plate and cold reduced galvanized

completed further installations at Pittsburg, consisting of a four-stand cold reduction mill and a second high speed electrolytic tinning line. This expansion included an additional continuous pickler, annealing furnaces, another side trim and recoil line, and a new roll shop. The mill warehouse facilities also were greatly increased there.

Coming now to the Los Angeles area, one very im-

portant change has been made at the Torrance Works since the war. The smog here is one of the more recent local problems, and our company is confident that it has done its part in eliminating smoke nuisance from our Torrance operation.

Early in 1948, Torrance Works undertook pioneering the control of emissions from the four 58-ton cold metal open hearth furnaces. Up to that time no attempt had been made in this country or abroad to effect a control approaching the degree demanded by the Los Angeles County regulations. Our investigation included extensive sampling, testing, and analyzing of both the gases and the particulate matter. Ultimately, four factors were given major weight in deciding the choice of equipment: first, the very fine nature of the dust, averaging about one-half micron in particle size; second, the corrosive nature of wet open hearth gases; third, the limited local water supply; and fourth, the temperature of the gases—about 1300 F. These considerations led to the installation of electrostatic precipitators of dry plate type preceded by waste heat boilers. The gases are delivered from the waste heat boilers at about 500 F.

This new operation proved very satisfactory. The average efficiency during acceptance tests was 98.3 per cent. The experience gained from the design, construction, and operation of this Torrance installation was used extensively in the subsequent installation of precipitators on the open hearth furnaces at United States Steel's new Fairless Works. This was a much larger job, however, requiring control of emissions from nine 275-ton furnaces.

There has also been occasion to draw upon this experience in air pollution control equipment in connection with the installation of gas cleaning equipment on the Geneva Works sintering plant, which is currently in progress. In addition, further test work, recently completed, is expected to lead to early installation of somewhat similar gas cleaning equipment at the ten-furnace open hearth shop at Geneva.

Adhering to the old proverb that a picture is worth a thousand words, the following pictures of some of these installations will take one on a quick trip around our western plants. Because of the significance of the Consolidated Western operations, a few pictures of the fabricating plants of the Consolidated Western Steel Division are shown in addition to those of the works of the Columbia-Geneva Division, the steel producing unit of United States Steel in the West.

Figure 2 — All U. S. Steel's western ore comes from open pit mines.

Figure 3 — Coal for Geneva comes from eastern Utah.

Figure 1 gives a general picture of United States Steel's operations in the eleven western states. In addition to these plants and warehouses, Cyclone Fence has a plant in Oakland and six warehouses at other locations in the area. The Oil Well Supply Division has outlets in fifteen cities in the West, Gerrard Steel Strapping is established in four cities, and the Union Supply Co. has a store in Dragerton, Utah.

Figure 2 is a view of the Desert Mound ore mine, a typical operation in southwestern Utah. All of our ore comes from open pits such as this. Large shovels, using up to ten cubic yards dippers, and trucks carrying up to fifty tons are used in the stripping of overburden ahead of mining.

Figure 3 shows the surface plant for the Geneva Coal Mine in eastern Utah, one of the two mines operated by United States Steel. To the right of the boilerhouse stack in the center of the picture is the structure housing the exit end of the 54-in. conveyor belt, which carries the coal from the underground rotary car dumpers up the main haulage way slope. The coal then travels by way of the covered conveyor at the extreme right to the blending bins and tipple. The other buildings include change house, administrative, and maintenance facilities.

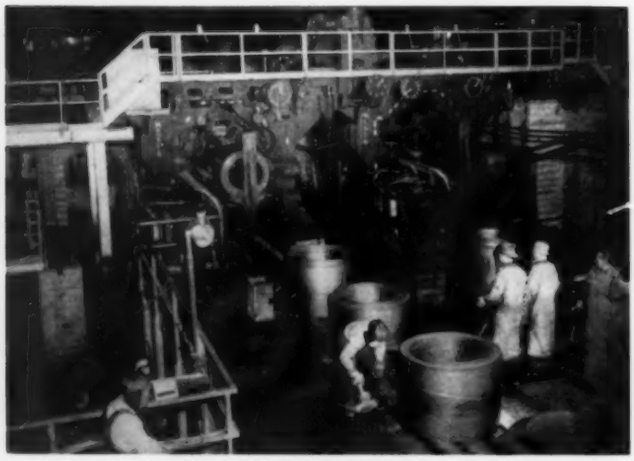
Figure 4 is a view of the Geneva plant, looking northwest toward Lake Utah. At the right are the coke ovens and the three blast furnaces. To the left is the open hearth shop. The plate and strip mill is just beyond the blast furnace in the picture. The structural mill and warehouse are to the left of the plate and strip mill toward the lake. Near the top of the picture beyond the plate and strip mill is the building housing the new hot rolled sheet shearing operation. The Geneva plant is on a 1500-acre site in Utah Valley at an elevation of 4500 ft above sea level.

A view of the Geneva 132-in. plate and hot strip mill in action is shown in Figure 5. This mill can process slabs ranging from two and a half to ten inches thick

Figure 4 — The Geneva plant of U. S. Steel is located adjacent to Lake Utah.

Figure 5 — The Geneva plate and hot strip mill can produce a wide range of products.

Figure 6 — Two breakdown coilers serve the Geneva strip mill.



and up to twenty feet in length and sixty-two inches wide. At the extreme right, the scale breaker is seen. In the foreground is the four-high spreading stand, and beyond is the four-high reversing rougher. In the distance are the six continuous finishing stands followed by runout tables, coilers, etc. These facilities, together with the forty-five-inch slabbing blooming mills and soaking pits are housed in a continuous building 3360 ft long.

The two downcoilers at the Geneva strip mill are shown in Figure 6. Hot rolled strip traveling at high speed along the runout table following the last finishing stand is deflected into the throat of one of the two cage-type coilers, which stand in a pit. After the coils, some weighing as much as ten tons, are formed, they are upended on to a conveyor which carries them through a large open trench across the plant yard. Many of these

Figure 7 — A hot rolled sheet shearing line was recently installed at Geneva.

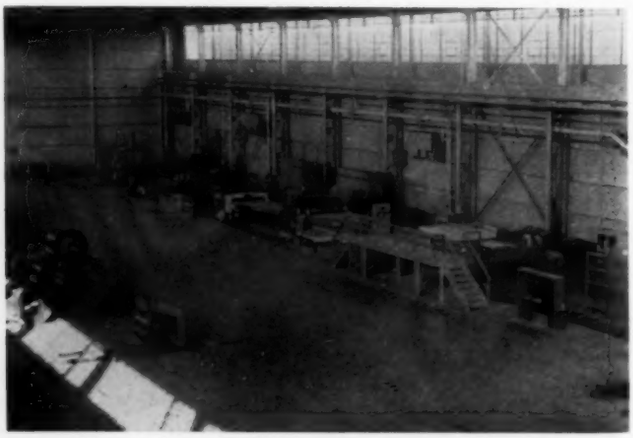


Figure 8 — The sheet and tin mill at the Pittsburg Works has 37.5 acres under one roof.

coils are shipped to the Pittsburg, Calif., sheet and tin mill for further processing.

Figure 7 shows the recently installed hot rolled sheet shearing line at Geneva. The line will process coils from 16-gage up to $\frac{3}{16}$-in. in thickness, and in sizes up to 72 in. wide by 240 in. long. The installation includes a processor, levellers and a flying shear. Additional equipment installed at the same time includes a two-high temper mill and a resquare shear.

In this air view of Pittsburg Works (Figure 8), the new sheet and tin mill is in the center foreground. There are 37½ acres under roof in this mill. These buildings house the four-stand and five-stand cold mills, the two electrolytic and fourteen hot dip tinning lines, and sheet finishing and galvanizing facilities. The rod mill is immediately behind the sheet and tin mill and beyond that the open hearth shop, rolling mill, and wire mill. The rope mill is across the tracks to the left just outside the picture.

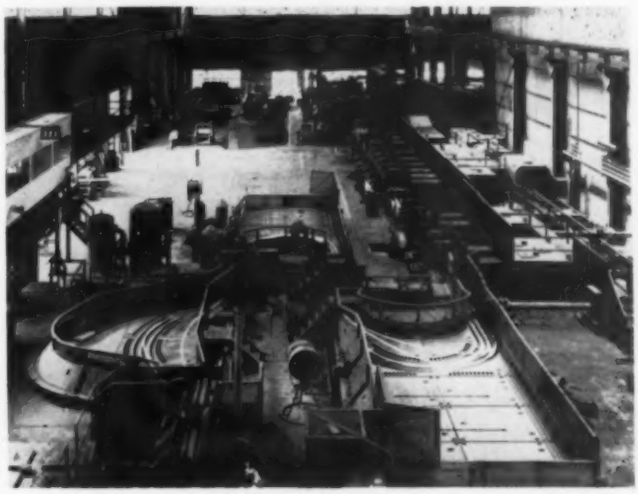
Figure 9 shows the 21-stand, three-strand rod mill, which was built in 1942. The billet furnace is shown in the upper right with the looping area in the foreground. Coiled rod, in sizes from No. 5 up to 1 in. rounds are produced. Smallest sizes leave the finishing stands at 4200 fpm. In addition to rods, we have produced on this mill $\frac{3}{8}$-in. concrete reinforcing bar in coils for subsequent straightening and cutting to length.

Figure 10 shows the four-stand cold reduction mill at Pittsburg Works, which can produce cold rolled strip up to 54-in. in width. Strip can be processed at a finishing speed of 3500 fpm. This line was put into operation at the end of 1951, and now produces most of our cold rolled sheet product.

The five-stand cold reduction mill which was installed in 1948 is similar to the four-stand, but is used primarily for rolling tin plate. It can operate at speeds in excess of 4000 fpm. It is located in the same building bay with the four-stand mill.

One of our newest installations at Pittsburg Works is this second electrolytic tinning line (Figure 11). The entry end with 60-in. outside diameter coils of cold rolled and annealed strip coming off the uncoilers is shown in the foreground. In the background is our first electrolytic tinning line, installed in 1948. The new line is designed to coat tin on steel at a rate of 1000 fpm in a continuous operation. Plating current on this line is now 75,000 amperes but will soon be increased to 120,-

Figure 9 — Both rod and small concrete reinforcing bar are produced on the 21-stand, 3-strand rod mill.



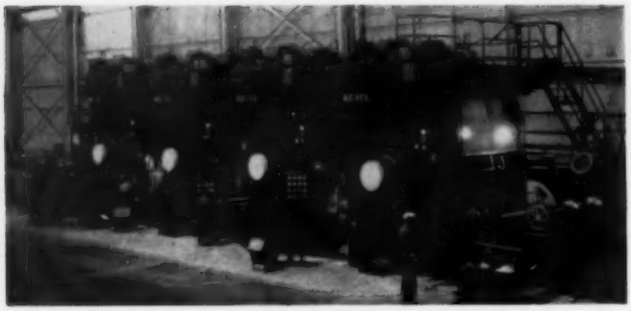


Figure 10 — The 4-stand cold reduction mill finishes at speeds up to 4500 fpm.

Figure 11 — The new electrolytic tinning line at the Pittsburg works is designed to operate at 1000 fpm.

000 amperes. The line is equipped with modern pinhole detectors and thickness gages for quality control of the product.

Figure 12 is an air view of Torrance Works. The open hearth shop is at the left. The large building in the center houses the rolling mills, the bar mill, and sheet mill. The warehouse building is in the background.

Figure 13 shows a closeup of the open hearth precipitators. Recently it was found that two of the 126-ft high concrete stacks had reached the point where replacement was necessary. Earthquakes had substantially weakened these stacks, and it was considered advisable to dismantle them. Further investigation, however, revealed that with the new air pollution equipment, which includes induced draft fans, tall stacks were not necessary. Therefore, the two weakened stacks were removed, and we now have a four furnace open hearth shop with a weird arrangement of two tall and two short stacks.

The South San Francisco plant is one of two Consolidated Western steel plants in the San Francisco Bay area. It is equipped with facilities for handling heavy plate fabrication, including tanks, pressure vessels, heavy wall pipe for penstocks and high pressure water lines, as well as large diameter expanded pipe for gas transmission lines. The plant is located on tidewater with ways and outfitting docks which were used for shipbuilding during the last war.

Figure 12 — Aerial view of Torrance works.

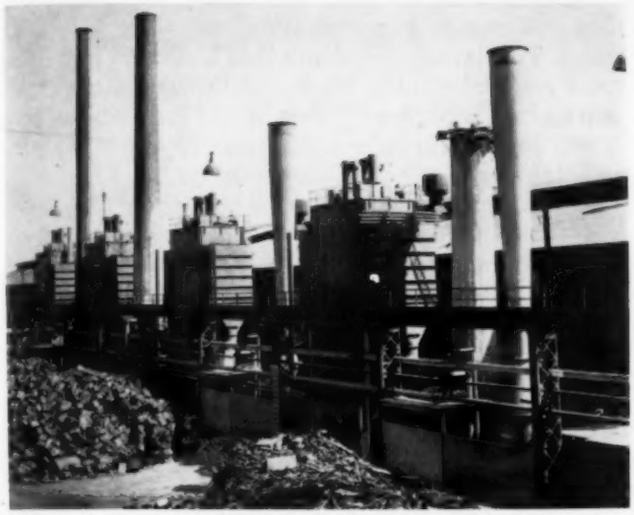


Figure 13 — Air pollution equipment with its induced draft fans eliminated the necessity for tall stacks.

The plant at Fresno, Calif., (Figure 14) is typical of some of Consolidated Western's small plants located in the outlying communities. The facilities are specifically tailored to meet the needs of those districts in which much of the work is related to the farming activity. The products include water well casing, culverts, propane and butane tanks, and light building structures

Figure 14 — The Fresno plant of consolidated western steel supplies material primarily for farming activities.

such as are required by the numerous cotton processing plants in the San Joaquin Valley.

The Maywood plant of Consolidated Western Steel Division of United States Steel is one of its two fabricating plants located in the Los Angeles area. It comprises some sixty acres and is equipped with modern facilities to handle a wide variety of plate and structural fabricated items, including buildings, bridges, tanks, large diameter expanded pipe, railroad car under-frames, etc. This plant contains a machine shop with some of the largest tools in the West, including boring mills, planers and other equipment.

The Maywood plant and its organization provides a unique outlet for conversion of our rolled steel mill products into an unlimited variety of special manufactured steel products. Its versatile activity is in keeping with the traditional ingenuity which characterizes this rapidly expanding area.

There is much talk about the phenomenal growth of the eleven Western states, but as long as this growth continues, it must be the guiding factor in planning. The population of the eleven Western states from 1940 to 1950 went from 14,000,000 to 20,000,000. The figure for 1960 is projected at 25,000,000. The estimate as of 1953 is 21,00,000 or 14 per cent of the national total. Actually, the 25,000,000 projected for 1960 is one of the more conservative estimates of the United States Bureau of Census. With the population almost doubled in 1960 over 1940, the West is shown as growing at a much faster rate than the rest of the United States.

People make markets, and as one looks into the future, one must be alert to the importance of providing capacity for those steel products and services which will attract new metal working industries to locate close to these growing markets. The West is rapidly becoming more self sufficient. It may be a long time before it is completely able to supply all of its steel requirements. An obvious example of an exception would be large wide flange shapes. But rapid strides are being made in the direction of emancipation in a wide variety of products which already account for the greater part of our requirements. Whereas in 1940 the West produced only 40 per cent of the steel it consumed, it now supplies 70 per cent. During 1953, the eleven Western states used approximately 7,000,000 tons of finished steel products. With continuing growth, this allows ample opportunity for substantial enlargement of our industry in the West.

The anticipated or possible future development of United States Steel in the West will not be covered in this paper. The past record of growth is shown in Figure 15. In 1930, our annual ingot capacity was 409,000 net tons. In the next eleven years this capacity increased nearly 30 per cent to a total of 522,000 at the beginning of the war. The addition of Geneva in 1946 raised capacity to 1,854,000 tons. With additions and improvements made in the last few years, we can now produce approximately 2,500,000 tons annually. This represents a 35 per cent increase just in the short period since Geneva came into the picture. Even the most conservative extrapolation of this curve would show an optimistic picture for the future. Beside the major additions to finishing facilities, there were a great many

Figure 15 — The construction of Geneva has been a key factor in U. S. Steel's growth in the West.

smaller additions and improvements to all facilities by which we have endeavored more adequately to serve growing and new industries on the West Coast with finished steel.

While this chart reflects development of the primary activity of United States Steel in the West "Steel Production," it is only one of a number of activities of our corporation in this rapidly expanding area. We have fabricating facilities for heavy construction, as well as plants for manufacturing consumer products, all the way down to pails and garden tools. We manufacture and erect fencing. We have special supply houses to handle the needs of the oil industry as well as large finished steel warehouses in the principal cities on the Coast. Each of these has had its own phenomenal growth which would make a story of its own.

All told, United States Steel employs over 20,000 men and women in operations in the eleven Western states. This is ample evidence that United States Steel has a real stake in the West, and through the fabrication and manufacture of its many end products of steel, it will perpetuate its contributions to the prosperity and stability of our Western economy.

Just growing up in the West is something of a privilege. Growing up with our steel industry here is a stimulating experience that carries with it all of the elements of an inspired pioneer type of thinking and living as well as the opportunity to apply those concepts to the tremendous fundamental business which is represented by the steel industry in this country today. The tide of industry is moving in our direction and steel will be well represented.

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Distribution Engineer
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Westinghouse Electric Corp.
East Pittsburgh, Pa.

. . . . in recent years there has been a decided trend toward grounding low-voltage a-c systems . . . .

▲ IN the early days of the use of electric power in industry most low-voltage a-c circuits had no normal connection to ground. This has remained true for many years, and it is only in the last ten or fifteen years that a decided trend has developed toward the use of grounded distribution systems in industrial plants.

The term ungrounded signifies that no metallic connection normally exists between any current carrying conductor or point in the system and ground. The neutral of an ungrounded three-phase system is normally very close to ground potential, being held there by the balanced electrostatic capacitance of each phase conductor to ground.

Grounding the system requires the connection of at least one conductor or point in the system to ground either by a solid metallic connection or through some form of current limiting impedance.

Figure 1 shows schematic and voltage vector relationships for grounded and ungrounded systems. There are advantages favoring both grounded and ungrounded systems and disadvantages to both, as will be pointed out in this paper. Whether for new construction or expansion of existing facilities, plant electrical engineers are more and more frequently faced with the question of which system to use — grounded or ungrounded. If the choice is for a grounded system, the companion question of how to ground presents itself.

UNGROUNDED SYSTEMS

Two factors are largely responsible for the use of ungrounded systems.

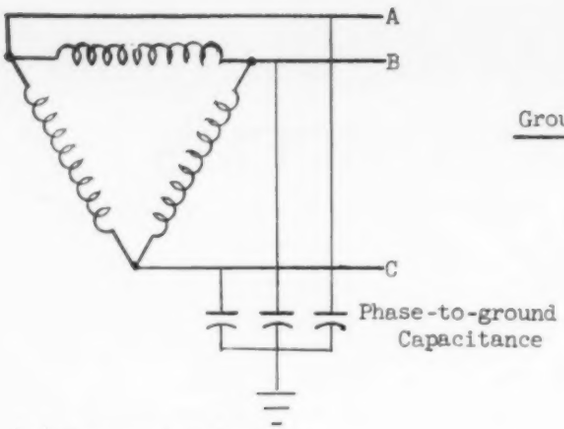
1. No immediate outage to any load is caused by the occurrence of a contact between one phase of the system and ground.
2. The cost of an ungrounded system is less than that of a grounded system.

The first factor of no immediate outage due to ground faults represents probably the chief advantage of the ungrounded system. Its importance, however, varies with the type of plant. The second factor of additional cost for the grounded system is usually small in relation to the cost of the system itself when a new installation is made and designed for grounded operation. Grounding may be considerably more costly for an existing ungrounded system without a readily available neutral point.

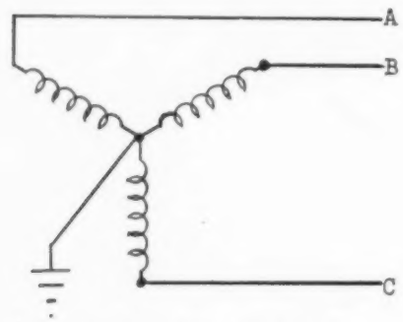
MULTIPLE GROUND FAULTS

Ground faults on one phase of an ungrounded system cause no service interruption. However, a second ground fault on a different phase occurring before the first fault has been cleared will result in fault current similar to a phase-to-phase fault and will result in an outage by tripping the circuit over-current device. If both faults are on the same feeders, only that feeder will be dropped. If the second fault is on a different feeder, both feeders will be dropped.

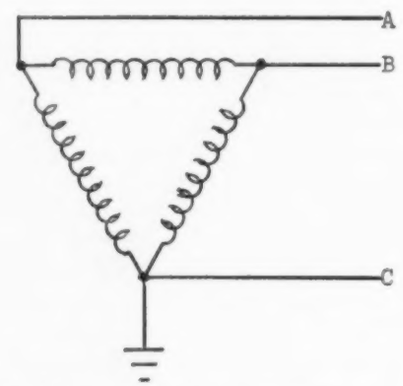
The longer a single ground is allowed to remain on the system, the greater is the likelihood of a second ground occurring on another phase resulting in an outage of one or possibly two circuits. The effect of this on the total circuit outage time for the ungrounded sys-



(a) Ungrounded System



(b) Grounded-Wye System



(c) Grounded-Delta System

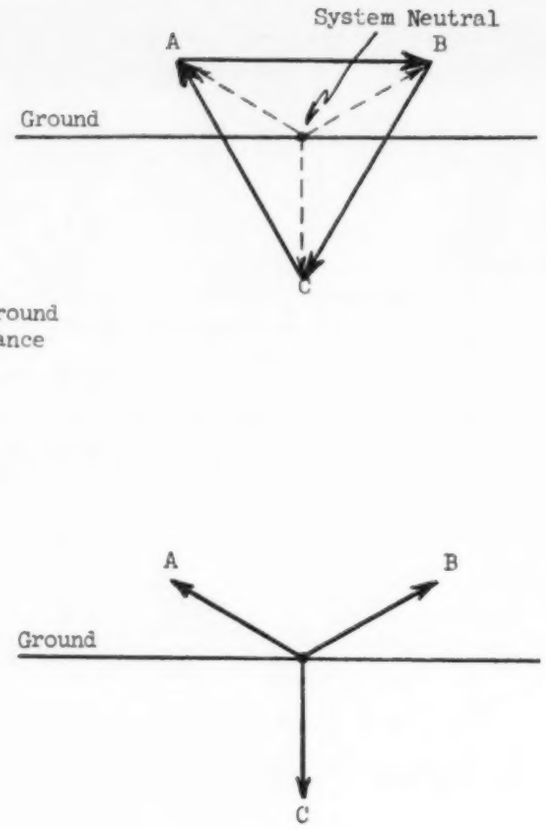


Figure 1— Sketches show voltage vector relationships for grounded and ungrounded systems.

tem is shown in Figure 2 for an assumed set of conditions. It was assumed that every outage on an ungrounded system involves two circuits which is somewhat pessimistic. This may be somewhat offset by the assumption that the time an ungrounded circuit is out for repair is the same as for a grounded circuit.

The curves of Figure 2 indicate that if grounds are removed in a short time after occurring, the number of grounds experienced per year must be quite high before the grounded system shows less outage time than the ungrounded system.

The practice of ignoring a ground until a second one occurs and repairs are required to restore service has been rather common in some plants operating ungrounded systems. While this laxity in maintenance is understandable, the result may well be more numerous and extensive outages than if the system had been grounded, thus largely destroying the advantage of the ungrounded system.

In order to best utilize the ungrounded system, a well organized maintenance program should be adhered to such that accidental grounds occurring on the system are located and removed at the soonest convenient time after their detection.

GROUND FAULT LOCATION

Many schemes have been used to detect and locate contacts to ground on the ungrounded system. Since

only very small values of current flow for such contacts, detection and location by visual disturbance or by observation of load current meters is generally impossible. The most common method of detecting the presence of a ground in a low-voltage system is to use lamps connected to indicate the potential between each phase and ground. Normally all lamps are lighted since the "floating" system neutral is held to ground potential by the capacitance of each phase of the system to ground. Should a ground contact occur on one phase, potential across the phase-to-ground capacitance and hence across the lamp in that phase disappears, the extinguished lamp indicating the presence of a ground and the phase involved.

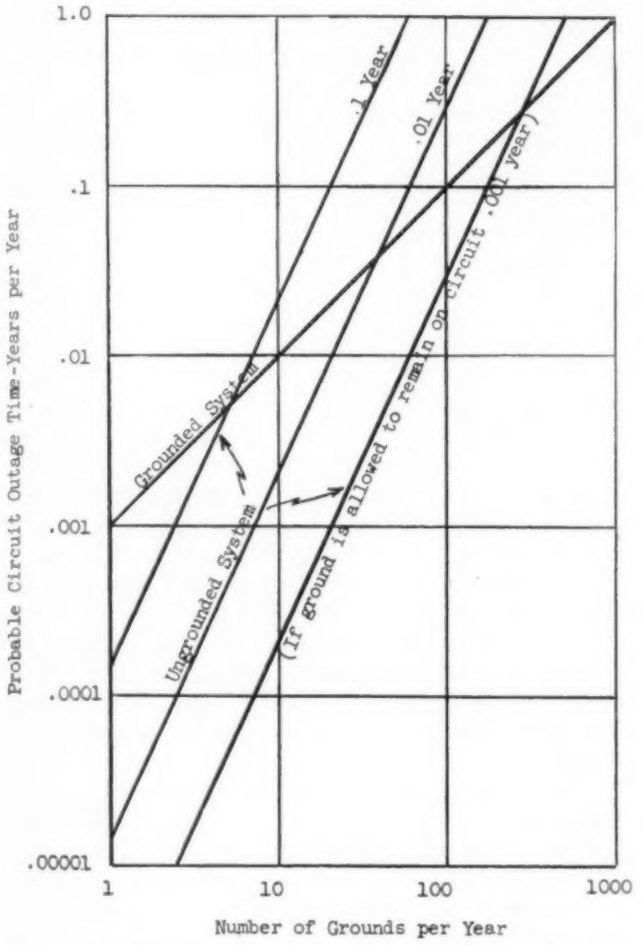


Figure 2 — Comparative annual circuit outage time for alternative grounded or ungrounded systems in the same plant illustrate the effect of allowing grounded circuits to remain in service on the ungrounded system.

Ground lamps, however, will not show on which feeder circuit the fault has occurred. Locating a ground fault on one feeder among a number of possible feeders out of one step-down substation may require removing one feeder at a time from service until the ground detector indicates the fault has been removed from the system. In the event that faults occur on the same phase of two different feeders at the same time, a different procedure is required. In such a case it is usual to deenergize all feeders from the substation concerned, restoring them to service one at a time, and checking the ground detector as each feeder is restored. The same general procedure may be used to locate the particular branch circuit containing the ground.

Other schemes have been successfully used to actually locate the ground point on a particular feeder. These usually involve some form of tracing current such as an interrupted d-c applied between the grounded phase and ground. The path of this current in the feeder is traced to the point of fault by means of a pick-up coil detection unit.

It is desirable in many types of plants to be able to locate ground faults without deenergizing feeders. Various schemes have been used with varying degrees of success. The advantage of such schemes is to permit locating grounds without waiting for light load periods in the plant. One company very successfully uses only an inexpensive low-reading portable voltmeter. While their low-voltage feeders are carrying load current a small voltage can be read between grounded-phase and ground. This voltage, caused by the load current flowing through the circuit impedance to the point of fault, will diminish becoming zero at the fault point. The voltage will likewise fluctuate exactly in unison with load current fluctuations on the grounded feeder. Hence, this method can be used to first determine which feeder is grounded and then to narrow down the fault location to a small area.

OVERVOLTAGES ON UNGROUNDED SYSTEMS

While overvoltages, both transient and sustained, may occur in any system from a number of sources, the problem of equipment failures due to excessive overvoltages in the ungrounded system is more and more being considered as a point in favor of system grounding.

Some of the more common sources of overvoltage on a power system are: (1) ground faults—arcing or solid, (2) switching surges, (3) lightning, (4) static, (5) circuit resonance under fault conditions, and (6) contact with higher voltage systems. Some of these overvoltages are transient and some may be sustained.

1. A common source of sustained overvoltage on an ungrounded system is when one phase of a three-phase system becomes grounded. In this case the insulation of the other phases is subjected to 73 per cent above normal voltage. A grounded neutral system would not have this overvoltage. While this voltage seldom approaches the insulation levels of equipment and circuits, the cumulative effect of higher than normal voltage stresses may somewhat reduce insulation life.

   Field experience and theoretical studies have shown that arcing or restriking ground faults on ungrounded systems can produce surge voltage as high as six times normal line-to-ground voltage. The conditions necessary for producing these overvoltages require that the dielectric strength of the arc path build up at a higher rate after each extinction of the arc than it did after the preceding extinction. This phenomena is unlikely to take place in open air between stationary contacts, because such an arc path is not likely to develop

sufficient dielectric recovery strength. It may occur in confined arcs where the pressure may increase after each conduction period. Neutral grounding is effective in reducing transient voltage build up from arcing ground faults by reducing neutral displacement from ground potential and preventing high frequency voltage oscillation following each fault initiation or restrike.

2. Normal switching operation in the system can cause overvoltages. These are generally not more than three times normal voltage and of short duration. Overcurrent devices such as circuit breakers or fuses, in general, interrupt a circuit at a normal current zero at which time the stored energy in the inductance of the circuit is zero. The overvoltages thus developed result from transient oscillation in the circuit capacitance and inductance. More serious overvoltages can be produced by devices which interrrupt by forcing current zero. Such devices as current limiting fuses must be carefully applied because of this overvoltage problem.
3. Most industrial systems are effectively shielded against direct lightning strokes. Many circuits are either underground in ducts or are within grounded metal conduits or raceways. Even open-wire circuits are often shielded by adjacent metallic structures and buildings. Lightning arresters applied at the incoming service limit the surge voltages within the plant resulting from strokes to the exposed service lines. Other arrester applications may be necessary within the plant to protect low impulse strength devices such as rotating machines or dry type transformers.

   Neutral grounding is not likely to reduce the overvoltages produced by lightning and switching surges. It can, however, distribute the voltage between phases, reducing the possibility of excessive stress on the insulation of a particular phase.
4. Buildup of overvoltage on power system conductors due to static charge is not usually a problem in modern plants with metal enclosed circuits and equipment. Static charge on moving belts can build up voltages which can be transmitted to the power system unless motor frames are properly grounded. Overhead open-wire lines may be subject to static overvoltages resulting from certain atmospheric conditions. A system ground connection, even of relatively high resistance, can effectively prevent static voltage buildup.
5. Unground systems may be subjected to resonant overvoltages if the system is large in extent. With greater amount of capacitance to ground in the larger systems there may be a condition of approximate circuit resonance during a line-to-ground fault through an inductance such as the coil of a motor starting contactor. The voltage to ground of the unfaulted phases will then be considerably in excess of line-to-line voltage. A grounded neutral system would prevent this overvoltage by holding the phases to their approximate normal voltage to ground.
6. Contact with a higher voltage system may be caused by a broken high voltage conductor falling on a lower voltage conductor where both lines are carried on the same poles, or by breakdown between the high and low voltage windings of a transformer. If the low voltage system is ungrounded, the high voltage will remain on the low-voltage system causing breakdown of insulation possibly at several points. A solidly grounded low-voltage system, though resulting in high values of fault current for this condition, will hold the system neutral close to ground potential and greatly reduce the overvoltages to ground on the low-voltage system.

GROUNDED SYSTEMS

Some advantages of the grounded low-voltage system are:

1. Somewhat safer for both personnel and equipment.
2. Reduced hazards from overvoltages.
3. Easier location of ground faults.

SAFETY

A solidly grounded low-voltage system probably has somewhat less hazard of accidents for personnel than a system that is supposedly ungrounded. If electricians treated all circuits with the same care and respect, the hazard of shock on an ungrounded circuit would be slightly less. However, there is often a subconscious tendency to be less careful in working on a normally ungrounded, energized circuit than if the circuit is known to be grounded. The hazard is that one phase of a circuit may be accidentally grounded and the other two phases, which the workman could normally contact safely, are then at full line-to-line voltage above ground.

There is also some hazard of shock to personnel should they bridge all or a part of the high impedance path between two accidental grounds on an ungrounded system. Under this condition, the impedance of the path between the two grounds may be high enough that not enough current flows to operate protective devices and open the defective circuits. Another hazard of this same condition is the possibility of fire from sparks or localized heating in the current path which may involve greasy shavings or similar inflammable material. Adequate grounding of equipment and structures will reduce these hazards even though the system itself is not normally grounded.

REDUCED HAZARDS FROM OVERVOLTAGE

The various sources of overvoltage have been discussed previously. There is considerable difference of opinion among engineers as to the likelihood of overvoltages occurring, and their severity on ungrounded low-voltage systems particularly as regards those resulting from an arcing or intermittent ground fault.

There remains substantial doubt in the minds of many engineers as to the seriousness of this problem. There appears to be a relatively small number of cases on record of severe, multiple failures of circuits and equipment which can be tied to the occurrence of an arcing or intermittent ground fault. It may be that because of the difficulty of substantiating the existence and magnitude of an overvoltage condition, such a condition was actually the cause of certain "inexplainable" failures in many plants. However, in spite of its wide usage, there is as yet no preponderance of evidence to indicate that the ungrounded system is generally unsatisfactory from this standpoint. It is, nevertheless, important to recognize that overvoltages can and do occur and that by system grounding, these are greatly reduced or eliminated with less likelihood of damage to equipment or circuit insulation.

EASIER LOCATION OF GROUND FAULTS

An accidental ground in a grounded system is both indicated and located approximately by an interruption of the accidentally grounded circuit. In a system having properly coordinated overcurrent devices such as circuit breakers or fuses, the ground fault should operate only the device nearest to it on the supply side. This together with the possibility of visual indication of the fault itself usually makes fault location in the grounded system relatively easy.

The arcing and burning caused by the relatively high ground fault current in the grounded system may be considered a disadvantage from the standpoint of damage to circuits or equipment. This is particularly true when the ground occurs between winding and core of a motor or generator. The resultant burning of the iron in the core may require complete rebuilding of the unit rather than simply rewinding it. The possibilities of this happening in low-voltage systems, however, are small due to the high opening speed of the overcurrent devices generally used.

WAYS OF GROUNDING

Low-voltage systems are generally grounded "solidly," i.e. with no intentional impedance in the ground connection. Solid grounding is used in order to obtain sufficient ground fault current to operate overcurrent protective devices. Ground relaying is rarely used in low-voltage systems, and the low-voltage circuit breakers, operated by self-contained series trip coils, require relatively high values of fault current in order to recognize a ground fault. Even a small value of grounding impedance is likely to reduce the current below the trip setting of the circuit protective device.

One exception to this is when grounding the neutral of a generator. The phase-to-ground fault current from a generator is likely to be greater than the three-phase fault current for which the generator windings are mechanically braced. The generator neutral should then be grounded through an impedance sufficient to limit the ground fault current to not more than the three-phase value.

WYE-CONNECTED-NEUTRAL GROUNDING AND CORNER-OF-THE-DELTA GROUNDING

One of the two basic schemes for grounding low-voltage systems is to connect the secondary sides of the power centers in wye, bringing out and grounding the neutral point at each power center. The other is to ground one phase or one corner of the delta-connected power center secondaries. These schemes are shown in Figure 1.

There are several advantages to the grounded-wye scheme. The most important one is that the phase conductors normally operate at equal voltages from ground. These voltages are less than the line-to-line voltage and less than the voltage-to-ground from two of the phase conductors when one corner of a delta system is grounded. The voltage stress on the conductor insulation is less in the grounded-wye scheme than in the grounded-delta arrangement. This is particularly significant in 575-volt circuits where the conductor insulation would be working at practically full rated voltage in grounded-delta circuits. The lower voltage stress to ground in the grounded-wye system probably decreases the number of insulation failures in machines and devices operated on 575-volt and 460-volt circuits.

The chief disadvantage of wye-connected-neutral grounding is its somewhat greater cost as compared to delta-grounding. Protective devices in the grounded-wye system should be equipped with an overcurrent element in each phase to recognize all ground fault conditions. This may require more expensive motor control devices, but present practice is to provide three overcurrent elements in all low-voltage air circuit breakers. Transformers for grounded-wye service on the low-voltage side cost from one and a half to six per cent more than delta-connected transformers. Usually it is not necessary to carry the neutral wire along with the three-phase circuits unless the circuits supply single-phase loads, connected from line to neutral as in 120/208-volt circuits supplying 120-volt lighting load. Therefore, there is no additional circuit cost to charge against the grounded-wye arrangement. The additional costs of grounded-wye transformers and controls with three overcurrent elements are appreciable when compared with the cost of the devices, but when these additional costs are considered as increases in the total system cost they are generally small.

NEW SYSTEMS

In recent years a substantial percentage of industrial secondary substation transformers for new plant installations have been purchased with wye-connected low-voltage windings suitable for neutral grounding. In new installations, these transformers offer the advantage that they can be used with an existing ungrounded system while having the neutral available for grounding if desired at some future time.

The small additional cost of the grounded-wye over the grounded-delta system can generally be justified in new systems by the advantages of the grounded-wye system.

EXISTING SYSTEMS

If the transformers have their secondaries wye-connected with the neutral point available outside the tank, there is very little trouble or expense in going to a grounded-wye system. It is likely this is not the case in most existing ungrounded systems, and there is considerably more incentive for grounding one phase and operating grounded-delta if grounding is considered desirable.

To obtain a neutral point for grounded-wye operation when the secondary substation transformers are delta connected, a grounding transformer is generally used. Such a transformer has its windings connected either in wye-delta or in a zig-zag arrangement so that they carry no load current but serve as a source of ground fault current. Grounding transformers for low-voltage systems must be relatively large in kva rating in order to carry the ground fault currents necessary to operate low-voltage protective devices. Their resultant rather high cost has prevented them from being widely used for grounding low-voltage systems.

SUMMARY

The basic reasons for grounding the industrial system are threefold: First, to limit the difference of electrical potential between all uninsulated conducting objects in a local area; second, to provide for isolation of faulty equipment and circuits when a fault occurs; and third, to limit overvoltages appearing on the system under various conditions.

The two advantages of cost and service continuity are responsible for the popularity of the ungrounded system. This is particularly true of the low-voltage portions of industrial systems which until recent years have nearly all been ungrounded.

There has been an increasing trend toward grounding in recent years, in order to overcome some of the disadvantages attributed to ungrounded operation.

It is the author's opinion that, in general, the grounded system is preferable, but that in plants where it is required, the ungrounded system can provide an additional valuable degree of service continuity under proper operation and maintenance conditions.

DISCUSSION

PRESENTED BY

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L. G. LEVOY, Industrial Power Engineer, General Electric Co., Schenectady, N. Y.

H. B. THACKER, Distribution Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

ERIC L. ANDERSON, Superintendent, Electrical Department, Bethlehem Steel Co., Johnstown, Pa.

D. L. Beeman: In our company, we have used grounded neutral 480-volt system now for almost 10 years, and invariably the experience has been excellent. The plant engineers, in some cases, where they have put in grounded neutral systems, have later grounded the existing ungrounded portion of the power systems.

For example, in our Schenectady Works, there is a 600-volt system. The portions of that system put in the last seven or eight years, have had wye-connected transformers solidly grounded at neutral. After operating grounded for a few years, the reduction in the number of ground faults led the plant engineers to put grounding transformers on most of the older delta-connected transformer units.

Today about one half of the 480-volt and 600-volt load center sub-stations which we sell are wye-connected. Five years ago wye-connected transformer units were not available as standard. At that time the percentage of 480 and 600-volt wye-connected was about 0.2 per cent.

I want to emphasize one point that Mr. Thacker made. Now there are two kinds of transformers, the delta and the wye. If the manufacturers had to make only one kind of transformer, you would get the advantage of greater standardization. His suggestion which I want to emphasize is that you buy transformers with the secondary wye connected, and then if you do not want to operate grounded, leave the neutral isolated. The neutral is there if you want to use it in the future. In that way the industry could use one type of transformer, which would satisfy both the grounded and ungrounded secondary winding service for most cases. The extra cost for doing that is somewhere in the neighborhood of $500 extra for, say, a 1,000 kva, which may have a selling price of $15,000 to 20,000. It is a very small amount of money.

I want to mention two case histories that indicate the effort of over-voltages on ungrounded neutral systems. One case is a central station auxiliary bus, operating at 480 volts from a transformer through a length of busway, to a switchboard, and then to the station auxiliary motors. Shortly after this station was put in service, one of the 480-volt motors failed to ground, and when it did, the busway flashed over, phase-to-phase, and of course, took the whole system out of service. The busway after failure withstood a 2,500-volt new hi-pot test. Although there were no recorders on this system, the indications were that in this case there was over 2,500 volts to ground on this 480-volt system.

Another case which is sort of a classical one, happened a number of years ago in a mill where they had many 480-volt motors, and these motors started to fail, to ground. The failure rate was very rapid, four or five in fifteen minutes.

The supposition was that there was a ground between the high voltage and low votlage winding in one of the transformers because when they measured the voltage to ground with a voltmeter, it went over the scale at 1,200 volts. Thinking that there was a ground connection between the high and low voltage windings,

they took the transformers out one at a time and checked them, but that did not solve the problem.

In the meantime they lost about 40 motors. About that time one of the electricians passed by a compensator that had been bashed in on the side, and he said it was smoking and buzzing on the inside.

What had happened, a truck had run into the compensator case and knocked the metal of the case almost, but not quite against a 480-volt coil terminal. Apparently it touched and then drew away starting the arc.

When they pulled the switch on the compensator, the voltage went back to normal and the motor failures stopped. To demonstrate what had happened a piece of wire was placed across the arcing path, but there was only 480-volts to ground on that phase where there was 1,200 volts when the arc was present.

L. G. Levoy: In the early part of Mr. Thacker's paper, he pointed out that one of the advantages of ungrounded systems was that there was no immediate outage on an ungrounded system if a ground fault occurred on one phase. Now this may be valid under some conditions, but not under other conditions. For example, if it should happen that when a ground fault occurs in one phase of an ungrounded system, producing displacement of the neutral and possibly transient overvoltages on the other phases, you may find that the insulation breaks down at some other weak point in the system, causing another fault. Thus, instead of having one ground fault on the system (which could be hunted down and repaired at a convenient time), you have two faults on the system, both of which cause feeders to trip out in two different areas immediately, giving a double outage and requiring immediate attention.

Now there is some difference of opinion among engineers as to the frequency at which these multiple outages occur, initiated by insulation failure at one point in the system. I want to point out that you engineers can really participate in, and contribute to, this study by watching your systems, particularly your low-voltage systems, for both multiple faults and single faults, and keeping records showing how many faults that you have on low-voltage systems occurring singly and how many occur as multiple faults. When you have evidence of multiple faults occurring simultaneously on ungrounded low-voltage systems, then you have pretty clear evidence that there are transient overvoltages on the system, and I believe that by keeping good records, we can establish the frequency of occurrence and take this matter out of the realm of speculation. I would like to suggest that you keep records both of multiple faults, and the number of single faults on your systems, both grounded and ungrounded, and then we will have some real evidence to show the benefits of grounding.

The second point is that I would like to inquire a little bit about the curves which Mr. Thacker showed. Curves of this nature are, of course, only as good as the assumptions on which they are based, and Mr. Thacker did not go into much detail as to the assumptions behind them. The only curves of this nature which would really be significant would be curves based on practical experience in systems. So again, I would suggest that you keep records along the lines previously mentioned, and I would like to ask Mr. Thacker if he would give us a little of the background of the assumptions on which these curves are based.

H. B. Thacker: The curves included with the paper are based on assumptions which of necessity are controversial. I agree with Mr. Levoy that, to be of most significance these curves should be based on experience. There seems to be no amount of experience available, and I concur wholeheartedly that it would be very helpful if the people that actually operate plants became more conscious of this problem and of the value of keeping records of faults on ungrounded systems. Such records would be valuable in deciding what is the best thing to do.

The curves are based on purely hypothetical assumptions, and they are worked up on the basis of probability. The assumptions, as far as the grounded system is concerned, are that every time a ground fault occurs, an outage will occur, which I think is a reasonable assumption, with proper over-current protection.

Also, we have assumed a value of time required to repair a fault on a grounded system. That value of time we have taken as 0.001 years or 0.365 days, or approximately one 8- hour shift.

For the ungrounded system we have assumed that an outage only occurs when two ground faults occur simultaneously, or when one fault occurs before the other fault has been cleared. I think it is reasonable to assume that a single ground fault will not cause an outage. When two ground faults do occur it was assumed that the outage involves two circuits. The curve coordinate of circuit outage time takes into account, that an outage on the ungrounded system involves two circuits.

While recognizing its controversial aspects, we have made the assumption that the same amount of time is required to repair an ungrounded circuit as is required to repair a grounded circuit. This may or may not be the case. However, with proper equipment, a ground can be located before you deenergize the circuit. If so, you are not piling up any circuit outage time for that condition.

Then as you start to accumulate circuit outage time, after deenergizing the circuit to repair it, an offsetting factor in this assumption is that there is probably less work involved in repairing a fault on an ungrounded system than there is in repairing a fault on a grounded system. Because of this, and for purposes of comparison, we felt it reasonable to assume the same repair time in terms of the circuit being out. That does not include, in other words, the time required to locate the ground.

We have, however, taken into account in this repair time assumption the fact that you are probably not going to repair both of these faulty, ungrounded circuits at the same time. You would likely repair one of them, restore it to service, and then repair the other one, so that the total elapsed time in terms of circuit outage time may be three times the repair time for one circuit.

We felt that we were being somewhat pessimistic

toward the ungrounded system in allowing three times the outage time for repairing the ungrounded system as compared to the grounded.

Now, those are the assumptions; the curves themselves were plotted up based on the usual probability theory.

Another assumption that I might clarify is that in every case that we have a circuit outage on the ungrounded system two circuits will be out. This is not necessarily true since we may have two faults on two different phases of the same feeder, which would only take one circuit out. But again in order to be pessimistic toward ungrounded systems we have assumed that two circuits are out in making this hypothetical comparison.

As I pointed out in the paper, I do not wish to advance this set of curves as proof that the ungrounded system has less total outage time than the grounded system. The purpose of the curves of Figure 2 is to illustrate the effect of some of the factors involved on the relative service reliability of ungrounded and grounded systems. One main point I hope to get across is that to get the best out of an ungrounded system, you must have some organized program for getting rid of ground faults. It has been all too common practice to leave them on the system, and just say, "Well, we will leave it on there, and when we get another one, we will have to do something about it." I believe such practice has been largely responsible for dissatisfaction with the ungrounded system.

L. G. Levoy: That does not quite answer my question, Mr. Thacker. On these particular curves, it appears that you are plotting grounds per year and assuming that you have the same number of grounds per year on both the grounded and ungrounded systems. I think that this is where the difference of opinion lies if there is any.

These curves should be plotted against outage time per year on both types of systems. If this is done, you may find that, on a particular grounded system, you might have one ground per year and it takes a certain length of time to fix it; whereas, on an ungrounded system of the same extent and characteristics, it is conceivable that you might have several grounds per year, (due to the more severe transient overvoltages which can exist on such a system). The coordinates should not imply that you will experience the same number of grounds per year on both systems, as this tends to make the curves misleading. The curves, to my way of thinking, are not plotted on the right coordinates to show the difference between grounded and ungrounded systems.

Now, perhaps this is the best you can do in the absence of any field data, and this is the reason that I appeal to the operators to get some factual data based on operating experience.

E. L. Anderson: I do not wish to enter into a discussion as to the merits of the ungrounded versus the grounded systems, but I merely wish to cover my experiences with the operations of power systems in the Johnstown Plant of Bethlehem Steel Company. Our 6900-volt system was operated for a good many years ungrounded, but due to the growth of the plant and the power system along with it, and due to the increasing number of failures from voltages induced by arcing grounds, it became apparent that it was necessary to ground the neutral on this system. The grounding of this 6900-volt, 3-phase, 25-cycle system was completed this summer and we have already, on one or two occasions, experienced the benefits of the grounded neutral system.

The 2300-volt, 3-phase, 25-cycle system in the Johnstown Plant covers a fairly large territory with several exposed overhead lines serving some of the mining operations. This system has always been operated ungrounded. Our experience with this system and other systems operating at 440-volt, 3-phase, 25-cycle and 220-volt, 3-phase, 25-cycle, has been entirely satisfactory. As a matter of fact, we are of the opinion that outages to the operating units have been greatly reduced due to operating ungrounded.

Each of the power stations from which the 2300-volt circuits emanate is equipped with ground detectors. When a ground appears, it is immediately located. While it is sometimes tedious and troublesome to locate the ground, nevertheless our experience has shown that this can be done, the ground located and removed with a minimum of delay or inconvenience to the operating department.

For the low-voltage systems, namely: 440 or 220-volt system, we use a portable ground-detecting equipment which has proved satisfactory in locating grounds on the system. On the low-voltage systems we favor the operation of banks connected delta—delta, as, in case of failure of one transformer, the bank can be operated at 50 per cent capacity.

H. B. Thacker: In answer to Mr. Levoy's last question, the curves of Figure 2 are not meant to imply that the same number of grounds per year will be experienced on both ungrounded or grounded systems. The abscissa being in terms of grounds per year means that the curves can be entered for some value of grounds per year for one system and its outage time compared with that for the other system and any other value of grounds per year.

Without an accumulation of field experience and data, the number of grounds per year for either system is largely conjecture. However, it is interesting to note from the curves that the ungrounded system can experience considerably more grounds per year than the grounded system before the total outage time of the ungrounded system equals or exceeds that of the grounded system. For example, if we assume 10 grounds per year on the grounded system the total outage time given by the curves is 0.01 years per year. The ungrounded system can experience about 70 grounds per year before accumulating as much outage time as the grounded system (0.01 years per year).

Because of the difference in slopes of the two curves, the above relationship varies with the number of grounds per year considered. However, based on the assumptions discussed previously, the curves indicate that the occurrence of ground faults must be 400 or 500 times per year before the ungrounded system can stand no more grounds than the grounded system without sacrificing service continuity.

By GEORGE S. RICHARDSON, Consulting Engineer, Pittsburgh, Pa.

FOUNDATION DESIGN FOR IRON AND STEEL PLANTS

. . . . if data on foundation conditions developed on the various construction jobs done for the steel industry were to be pooled at a central source, it would prove to be of great value on future jobs . . . .

▲THE particular phase of foundation design which will be covered in this paper relates to the determination of safe soil bearing loads and safe pile loading. In thinking about how to approach this rather complex subject, it is more interesting to consider just a few specific conditions rather than to attempt in a brief paper to cover the whole field in a general way. Therefore, just three foundation problems, quite different in character, will be considered.

The first example occurred in connection with the construction of one of the piers for the Liberty Bridge over the Monongahela River in downtown Pittsburgh. Although this particular foundation was for a highway bridge, the principles in connection with it are equally applicable to machinery or mill building foundation design.

Most of the piers for this bridge were founded on shale, but one, which was constructed to support the adjacent ends of two simple spans, was founded on clay. Existing records are not complete enough and after about 30 years, memory is a little too vague to give accurate descriptions of the soil conditions. The bottom of the footing was placed about 15 ft below ground surface. This was the top of a bed of clay at least 20 ft thick, and perhaps even up to as much as twice that, overlying shale. It was the opinion of all the engineers except one connected with this project that the pier should be supported on piles. The one who was in disagreement happened to be the head of the department, and with the prerogative of that position decided that the pier should be constructed on a spread footing.

The footing, some 22 by 61 ft in plan dimension, was completed early in February in 1926. Beginning at that time a check was started to determine the amount of settlement as time elapsed and additional load was added.

The record as shown on Figure 1 is for the west end of the pier but was substantially the same for the east end. By the time the pier had been completed, there had been a settlement of about 3 in. This had increased to approximately 5 in. by the time the steel erection had been completed and continued to increase by fairly

Figure 1 — Chart shows settlement for one of piers under Liberty Bridge over the Monongahela River.

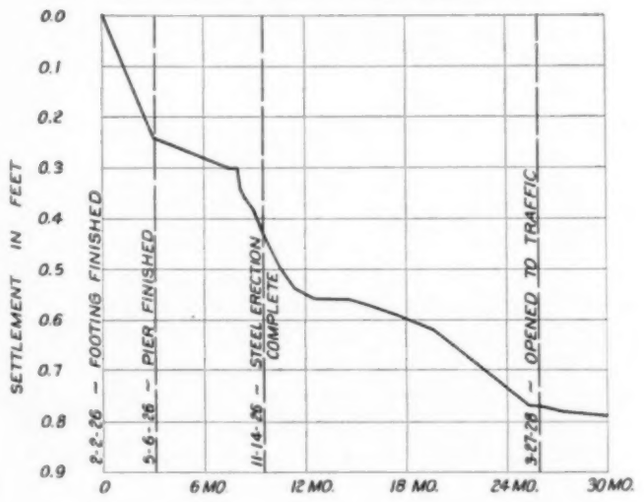
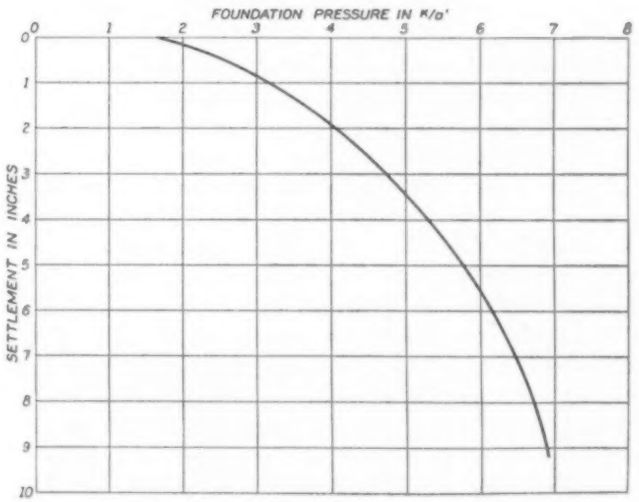


Figure 2 — When settlement curve is plotted against foundation pressure, data for Liberty Bridge pier does not give same impression of security as curve shown in Figure 1.



large increments up until the time that the bridge was opened to traffic a little more than two years after the footing had been finished. At that time the total settlement was over 9 in. For the first five months under traffic there was a very small increase of only a quarter of an inch, and this rate of settlement continued to decrease so that over the period of the next four years the settlement amounted to only ½ in.

The time-settlement curve as shown on Figure 1 tends to give a feeling of security about the condition of the pier. Although settlements were large, after each addition of load there is an indication of stabilization, and if the curve is continued out for a number of years it of course becomes very flat. This feeling of security, however, disappears when a foundation pressure—settlement curve, as shown on Figure 2, is examined.

This curve shows quite clearly that for any load over 3,000 to 3,500 lb per sq ft the supporting soil would be loaded beyond what would normally be considered a safe bearing pressure, and with a load of about 7,000 lb per sq ft, which existed at the time the full dead load of the bridge was on the pier, this foundation surely was near failure. Full live load would increase this pressure by perhaps another 1,000 lb per sq ft. Fortunately the ultimate capacity of the soil, however, was sufficient to carry the superimposed loads without failure, and over a period of 25 years under traffic the pier has continued to give satisfactory service. From the beginning, there has been a slight break in grade over this pier, because although the total ultimate settlement had been estimated during construction and allowance made for it in setting the shoes, the actual settlement exceeded the estimated by more than 2 in., resulting in the bridge deck being low by this amount over the pier.

Until a foundation engineer has been through this kind of an experience, he is inclined to think of design in terms of perfectly stable supports free from any movement under load. Such design, however, is impossible, and under many conditions any close approach to it may be quite wasteful. In other words, the art of good design, and particularly for soil bearing footings, is the determination of a bearing value which will keep settlements within tolerable limits. The nature of the structure to be supported, therefore, plays an important role in determining what may be a safe bearing pressure. Very small differential settlements may be disastrous for certain types of equipment, while for some other construction quite large differential settlements would not be in any way harmful.

The most important general conclusions to be reached from a study of this particular problem are:

1. Design all soil bearing footings on the basis of predicted settlement.
2. Dead and constantly applied loading requires more careful consideration than live or intermittent loading.
3. Do not grout machinery or equipment base plates for final setting until all of the dead load is on the foundation.

The next example will be taken from data furnished by Jones and Laughlin Steel Corp. for a number of pile loading tests made within the past three years. It happens that these pile tests were made on the same river bottomland along the Monongahela River on which the Liberty Bridge pier was constructed, but a few miles upstream. In the area where the tests were made, shale is located roughly 70 ft below the present ground surface. The deep beds of shale are grey, hard, and fine-grained, but overlying this is a thin layer of variegated shale from a few inches to two or three ft in thickness. This variegated shale is rather soft. The overburden is a conglomerate mixture with some sand, but largely silt and clay.

It would not be practicable to carry large loads on spread footings, and for a large construction program it had been decided that most of the structures, buildings, and machinery would be carried on piles. Conditions clearly indicated that these piles should be driven to the shale and that most of the load would be carried by point bearing. It was desired to utilize steel bearing piles at their maximum capacity, and in order to establish safe design loadings, a comprehensive series of load tests was conducted with 89-lb and 117-lb sections. The writer was not in any way responsible for any of these tests, but through the courtesy of Jones and Laughlin Steel Corp. the results have been made available to him, and they include some valuable information on the action of highly loaded point-bearing piles.

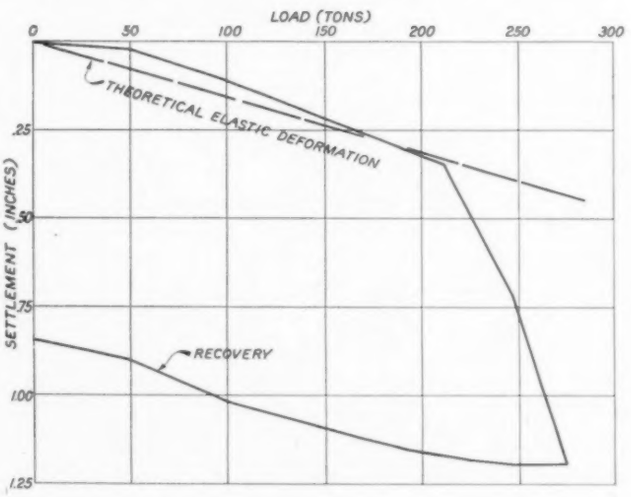
The 89-lb sections were driven with a single-acting hammer of 6,500-lb weight and a drop of 3 ft. The initial driving of 117-lb sections was performed by the same hammer, but completed with one having a weight of 10,000 lb and 3½ ft drop. These hammers deliver energy of 19,500 ft-lb and 35,000 ft-lb respectively.

Through the overburden, the hardest driving ranged up to about 40 to 50 blows to the foot, but as the points of the piles penetrated the variegated shale, resistance increased very rapidly. In order to get much penetration, it was necessary to drive the piles very hard, and for the test they were finally seated at resistances ranging from 25 blows to 50 blows per inch. This is very hard driving with such heavy equipment.

The results of one of the load tests for one of the piles are shown on Figure 3.

This particular pile was one of the 117-lb sections and had been driven to a final resistance of about 27 blows per inch. The performance under load test was excep-

Figure 3 — Pile load test data for 117-lb pile driven in bottom lands along the Monongahela River were obtained by the Jones and Laughlin Steel Corp.



tionally good. Up to a total load of about 213 tons, the settlement for the top of the pile followed very closely the curve for theoretical elastic deformation, assuming the whole load carried in point bearing. At this load, the unit stress in the pile was about 12,400 psi. When the load was increased to a total of 275 tons, the settlement increased fairly rapidly, but even at that load reached a total of less than 1¼ in.

Tests for all of the piles did not show such remarkably good results as for the one diagrammed on Figure 3, but for the 89-lb sections driven with the lighter hammer, performance in every case was very satisfactory up to a load of 130 tons. For the 117-lb sections driven with the heavier hammer, and particularly for piles for which the final driving was in the range of 50 blows to the inch, performance was remarkably good up to a load of 165 to 170 tons. For one or two tests, settlements became fairly large for loads over 200 tons, reaching a maximum for one pile of about 6 in. at a load of 275 tons. This was one, however, which had been driven only 25 blows to the inch, and for a load of 165 tons the settlement had been only 0.4 in.

General conclusions which may be reached on the basis of these tests are:

1. Point bearing piles can be designed to carry very heavy loading with safety provided the capacity of the bed rock is adequate.
2. There is no magic formula of 25 blows or 50 blows to the inch which may be used to prove that the piles are correctly seated, but final driving must be hard, and, except for well known conditions, needs to be checked by tests such as those described.
3. Some settlement will occur for foundations so supported, but can be kept to very low values.

As a final example reference will be made to a foundation study for supporting a blast furnace to be constructed in the Cleveland area. At this location, there is a very compact hardpan reached at a depth of 100 to 120 ft below the ground surface with an overburden of about 60 ft of lake bed clay, and above that roughly 30 ft of sand of varying compactness, and finally about 10 ft of old fill. The sand, particularly in the upper layers, is not sufficiently compact to carry spread footings with any sizeable loading, and after borings had been completed, it was quite obvious that the blast furnace should be supported on a pile foundation.

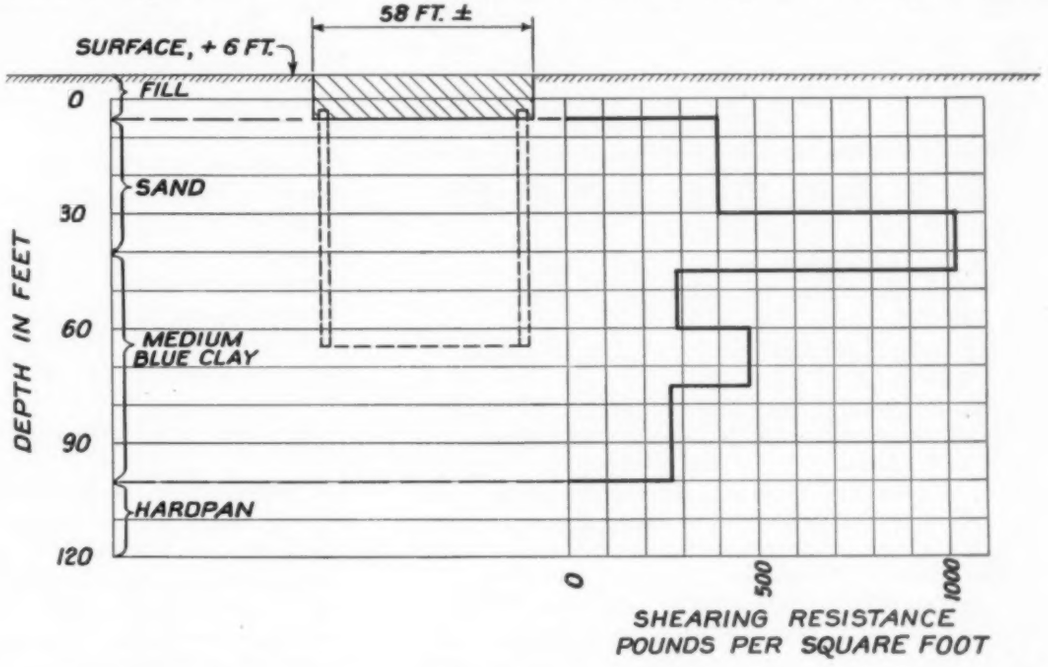


Figure 4—Sketch shows a typical soil condition and pier foundation designed to suit this condition.

As a result of these tests, the 89-lb sections were designed to carry 130 tons per pile, and 117-lb sections to carry 170 tons per pile, it being specified that the former be driven to resistance of at least 25 blows to the inch with the lighter hammer, and the latter to 50 blows to the inch with the heavier hammer. At these loads, the sections will be stressed to about 10,000 psi. Some of the piles were driven with points which had been reinforced by the addition of plates and angles. The test did not show any clear indication of improvement of performance by reason of this reinforcement, and in fact in one case there was some indication that the reverse might be true. Similar tests have shown that 14-in. diameter pipe piles, driven either with closed or open ends and filled with 5,000-lb concrete, can be utilized for design loads of 200 tons each with a large margin of safety, with the point of the piles on the deep bed of hard grey shale.

In order to make a detailed study of the conditions, undisturbed samples were taken during the final boring program and laboratory tests made to determine all the soil characteristics, including among other things unconfined compression tests and transverse shear tests.

Figure 4 shows on the left side typical soil stratification, on the right a diagram for average shearing resistances as determined by the laboratory tests, and in the center a diagrammatic outline of the construction for the foundation which was recommended. A number of arrangements would be possible for the piling. Long piles might be used and driven into the hardpan, in which case a portion of the load would be carried by point bearing and the remainder distributed to the overburden. Relatively short piles of perhaps 30 to 40

tons capacity might have been used. The solution recommended involved the use of piles about 60 ft long driven through the sand and into the medium blue clay.

Two entirely separate but related problems must be considered in the design of a foundation of this type. One limitation is the capacity of the individual pile. For conditions as exist at this site, this is determined primarily by the area of the perimeter of the pile and the safe frictional resistance. The latter is directly related to the shearing resistance of the soil. The second limitation is the capacity of the soil to support the core formed by the soil mass enclosed within the outline of the outer row of piling. This core is in a sense another type of spread footing carrying the load from the bottom of the foundation mat down to a level at the point of the piles. Its ability to carry its load is dependent upon frictional resistance around the perimeter of the core, and the supporting capacity of the soil at the bottom of the core. In a well balanced design, capacity determined by individual pile loading multiplied by the number of piles, and capacity for the core as a whole, will be approximately equal. In order to obtain this condition at the Cleveland site, pile loading was limited to 60 tons per pile and pile spacing to a minimum of 3 ft 9 in.

General conclusions to be reached from this example are:

Foundation design for such a condition requires good borings, undisturbed samples, careful laboratory tests, and consideration of alternate possibilities during design. Consideration of possible settlements is as important as in the design of spread footings.

In concluding this paper, the author would like to make a suggestion which might within a reasonably short time bring great accomplishments. Members of the AISE are almost constantly in close contact with large construction projects involving a great variety of foundation conditions. Tremendous advances in better foundation design could be made by having more widely available the results of load tests, laboratory tests, and other information gathered during the design stage, and, most important, actual performance tests of foundations as constructed.

It is suggested that the AISE should create a special organization charged with the collection of such data. If properly organized, this could be a project which would be of tremendous value to all of its members concerned with such problems and also make a remarkable contribution toward the advancement of foundation design.

DISCUSSION

PRESENTED BY

M. M. LACHOWSKI, Mechanical Engineer, Lewis Machinery Div., Blaw-Knox Co., Pittsburgh, Pa.

GEORGE S. RICHARDSON, Consulting Engineer, Pittsburgh, Pa.

W. R. EGGER, Supervisor — Design, Primary Rolling Mills, United States Steel Corp., Youngstown, Ohio.

L. H. CHATER, Chief Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

M. M. Lachowski: In order to evaluate loads on a foundation, especially on a steel mill foundation, we have to know the static and the dynamic loads. I would like to find out how you determine the dynamic loads, for instance, for a rolling mill. It may happen that a billet will get stuck in the rolls, and that will engender a dynamic load. How do you determine that?

George S. Richardson: It is done ordinarily rather arbitrarily, but on the basis of experience and usually by a percentage addition to the live load. Actually, it is my opinion that ordinarily this dynamic effect is not very important and that the real important factor in all foundation design is the dead load which is present all the time. Naturally, if you are designing for very heavy cranes, you must make allowance for the live load, and you must make allowance for lateral loading and for dynamic effect. However, you can get more radical with your allowances for foundation pressures for that type of loading, than for the loading which is there constantly, and that is the dead load.

M. M. Lachowski: A continuous rod mill is presently under construction by my company in a foreign country. As it is usual in such cases, the construction of the foundations was entrusted by the owner to a local engineering firm. The latter has made extensive investigations on the soil characteristics of the erection site, and asked for information on the static and dynamic loads occurring in the different parts of the rod mill. A scanning of the data available on this question in American, English and foreign technical literature resulted in a very meager haul as far as the special application to steel mill foundations is concerned. The nearest approach in this respect was an article in Stahl & Eisen, 60 (1949, No. 23, Nov. 19), entitled "Planning and Construction of Machinery Foundations in Steel Works," by Kurt Hurshmann.

The article deals with the planning of foundations from the operational point of view; it gives, in a general way, hints for economical construction, accessibility, drainage, cleaning facilities, etc. The following quotation is of particular interest:

"One should be very cautious not to make a quite commonly occurring mistake by taking into consideration the static loads of the pertaining machinery only. In the majority of cases the dynamic loads are by far the greater and they should be taken into account. This is also valid for steel plant foundations. The heavy concrete blocks will practically never be stressed beyond the allowable limits by the machinery weights alone. However, the dynamic forces may be of such magnitude that the provided foundation dimensions will not be adequate, especially in emergency cases. If, for instance, the rotating masses are brought to a stop inside of a few seconds, then the dynamic forces may become colossal. This happens, for example, when there is a cobble in the rolling stands, which occurs oftener than one would expect. Thus, the foundation calculations must include stresses occasioned by static as well as dynamic forces."

The thought underlying this quotation served as a

basis for the calculation of the dynamic forces occurring in the different parts of the above mentioned continuous rod mill. The loads on the foundations occasioned by them were by no means inconsiderable, amounting in many cases to over 100 per cent of the static loads.

George S. Richardson: I believe we are considering two different problems. Mr. Lachowski is thinking primarily of the effect of dynamic loads on the foundation pads. I am thinking in this instance of the effect of dynamic loads on allowable soil pressures or allowable pile loading with which this paper is primarily concerned. It is true that the dynamic effect of some types of equipment may be very large, and, as Mr. Lachowski states, on the order of 100 per cent of the static load effect is not unusual. For this reason it may be necessary to increase the mass of the foundation pads considerably over that which would be required for static loads alone. Special consideration also must be given to the stress conditions within the foundation pads.

The effect of the dynamic loads, however, on foundation pressures or on pile loading is in my opinion not a very important factor. Even for equipment for which the dynamic effect is large on the foundation pads, there will be of necessity a large mass of concrete placed in the pads with the result that the ratio of the dynamic effect to total dead load of equipment and pads will be small. I should not go so far as to indicate that dynamic effect can be entirely ignored in considering allowable soil bearing pressures or pile loading, but in the very large majority of cases it can be neglected.

Member: You say that you make allowances in the design for settlement. In some continuous structures, the stresses can vary very greatly, if you assume that some supports deflect more than others, and that can complicate calculations very much. I wonder if the job was redesigned after it was found out that some piers would settle more than others?

George S. Richardson: My approach to that problem can be illustrated by a specific example. We are designing a structure over the Delaware River to connect the Pennsylvania and New Jersey Turnpikes, and the approaches include several continuous truss spans. We have estimated, on the basis of soil tests which have been made, that the maximum settlement for the spread footings will not exceed about three-quarters of an inch, and that the differential settlement will not be over a half inch at the most.

So we are checking the trusses to determine how much influence that has on the stresses, and in this particular case, it is very little.

For a continuous structure differential settlement of supports is of course an important factor. The correct procedure then is to determine by soil exploration and tests the possible amount of this differential settlement and to design accordingly. For spread footings, it may be necessary to increase the size to reduce differential settlement to a reasonable amount. Perhaps it will not be possible to use spread footings, and some other type of support such as piling must be used. In some cases the cost of controlling differential settlements within reasonable amounts will be so high that a change in the type of structure is indicated from the continuous to a statically determinate form.

W. R. Egger: Would you describe the best method for checking your number of blows per inch in the final driving of piles?

George S. Richardson: Ordinarily it is not a difficult thing to check the number of blows in driving piles. Normally you may be checking something in the neighborhood of 50 to 60 blows per foot, which is fairly hard driving for friction piles. This can be done by marking increments on the pile and counting the number of blows per inch by reference to a fixed mark on the leads. If great accuracy is required by reason of compiling test data such as for the point bearing piles which were discussed, readings can be taken by instruments.

Member: I wonder if Mr. Richardson might answer from his experience, a question on a setup where you have a large number of units of equipment such as rolling mills, whether you can perhaps construct it all on a single mat or if it is better to build individual foundations for the individual units? We have a problem here of a distribution of concentrated loads, alternated by simpler loads. Have you found a preference, or have you found any situation where a single mat might be preferable to the individual piles?

George S. Richardson: Where it is applicable, the single mat is very much to be preferred. It is very difficult to analyze the pressures under the various parts of the mat, but the chance of avoiding differential settlements is much better than for the case for which separate foundation units are used. Much of the heavy equipment at the Fairless Works was placed on large single mats, and this system was found very satisfactory.

L. H. Chater: The author deserves our thanks for a constructive paper on a subject which is seldom given the prominence it deserves. I am sure he will agree that heavy expenditures are frequently incurred by unnecessary piling. Would Mr. Richardson explain the methods used for predetermination of settlement? On sites where piling is indicated to avoid anticipated large settlements, would it be possible to eliminate the piling by accelerating site settlement by means of preloading?

George S. Richardson: I agree with Mr. Chater that in many cases heavy expenditures are incurred by unnecessary piling. It is always easy for the designer to take the conservative approach and eliminate the spread footing in favor of some other type of more expensive foundation, such as piling. The science of soil mechanics has advanced to the point where experts in this field can make quite accurate predictions as to the amount of settlement which will occur under different conditions of loading. In order that this may be done, a carefully planned program of soil exploration and soil tests is required. Soil sampling must be done by a standard procedure, which can be related to experience on prior tests. For cohesive soils it is necessary to take undisturbed samples and make laboratory tests to determine the soil characteristics. In some cases, soil bearing tests may be required at the building site.

I do not believe that, except for some very special condition, preloading is a feasible method of increasing soil bearing capacity. Recently a method has been used to increase the capacity of granular soils by an increase of density secured by compacting the soil by vibration.

Water Supply for Steel Plants

By ROSS NEBOLSINE
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. . . . water is essential in steel plant operations . . . . steel plants are also industry's second largest user of water . . . .

▲ THE purpose of this paper is to point out the important role of water supply in the steel industry. This will include a description of the water demands of integrated steel plants, the principal features of the water systems used, the methods of utilization of the available supply, the quality of water required and plant distribution systems. Various types of water abstraction installations, depending on the available sources of supply, will be illustrated by examples of water intakes designed by our firm. Finally, engineering factors for water supply expansions and improvements will be briefly reviewed.

WATER REQUIREMENTS OF STEEL PLANTS

The total industrial use of water in the United States is now estimated to be about 100,000,000,000 gallons per day. This does not include water passing through hydraulic turbines for the production of power. A similar amount is used for irrigation, but the total municipal and sanitary requirements are only a fraction thereof. (See Table I).

Of the 215,000,000,000 gallons per day, about 18 per cent is groundwater and 82 per cent represents surface water. Of the 100,000,000,000 used by industry, only 7 to 8 per cent is of groundwater origin.

TABLE I

Estimate of Use of Water in the United States (Not including Atomic Plants)

Class of use	Billion gallons per day	
	1950	1953
Hydropower	1150	1300
Irrigation	80	95
Industrial	80	100
Municipal	14	16
Rural	4	4
	1328	1515

If we consider the industrial uses further, we find that more than three-fourths of the total is used for cooling purposes and therefore, in most cases, the water can be returned to its source without appreciable change in quality, except for a slight rise in temperature. This serves to indicate that, although stream pollution by industry constitutes a tremendous problem, waste treatment in any form need be considered for less than one-fourth of the total circulated industrial supply.

In the aggregate, public utility steam power plants are the greatest users of industrial water accounting for about 60 per cent of the total. Next come the steel plants, which are followed by the oil refineries, unless it is the atomic plants. (See Table II).

When we consider the volume of water actually used, that is pumped and circulated by steel plants, we have two widely differing unit figures. On the one hand is an estimate of 150 tons of water per ton of finished steel, which was made some time ago by the American Iron and Steel Institute; and on the other hand is the recently widely circulated figure of 65,000 gallons or 250 tons of water per ton of steel.

This discrepancy probably arises from three causes:

a. Whether the water requirements of the steam power generating plants of the steel companies are included or not.
b. Whether the requirements of steel end product manufacturers and fabricators are included or not.
c. The larger unit use of water by the newer plants.

Our firm's studies of the actual pumping rates of various integrated steel plants, if one excludes use of water for electric power generation, and making no allowance for steel end product manufacturers, point to an average of 40,000 to 45,000 gallons or 175 tons of water per ton of finished steel. However, the conditions at different plants vary considerably. If water use control and conservation is practiced, only 30,000 gallons is

circulated per ton of steel. The highest unit use, of approximately 65,000 gallons per ton, is to be found at plants situated on the Great Lakes, where a practically inexhaustable supply is easily available and restrictions in water utilization are not necessary.

TABLE II

Estimate of Use of Water by Industry in the United States (Not including Atomic Plants)

Class of use	Billion gallons per day	
	1950	1953
Public utility thermal power	52	60
Iron and steel	11	12
Oil refining	6	7
Atomic	....	....
Paper and wood pulp	3	4
Synthetic rubber	1	1
All others	8	11
	80+	95+

It therefore follows that on the basis of the current annual production of 80 to 85,000,000 tons of finished steel, the daily pumpage of water by the country's steel plants is about 9,000,000,000 gallons per day, or almost 10 per cent of the total industrial water requirements. If one includes the steam power plants located within the steel plants and the steel end product manufacturers, this figure should be increased by about one-third to 12,000,000,000 gallons per day, or four cubic miles of water per year.

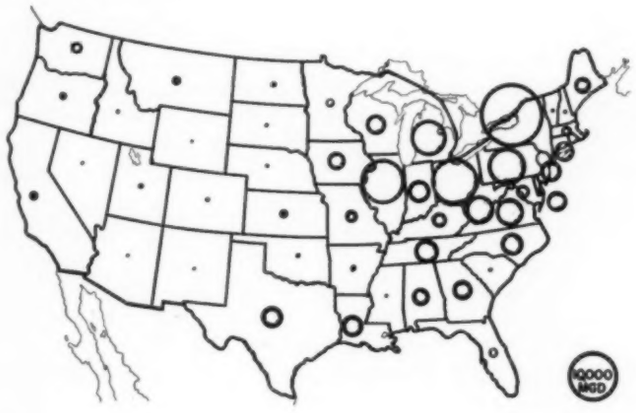


Figure 1 — Chart shows industrial use of water by states for the year 1950 based on data from USGS circular No. 115.

If proof is necessary that these estimates are not exaggerated, we can state that just five of the larger steel plants with which we are familiar, each circulated between 400 and 1,000,000,000 gallons through their various water systems, including cooling water for their steam power plants. Between them, they use about 3,000,000,000 gallons per day, while accounting for less than 25 per cent of the nation's production of steel.

Figure 1 shows the distribution of industrial water supplies in the United States. It will be observed that most industrial water is used in those sections of the country that have the largest steam power and steel plants (New York, Pennsylvania, Ohio, Indiana, Michigan and Illinois).

UTILIZATION OF SUPPLY

The question arises whether, in view of the enormous demands, we may be running out of water. The answer is in the word use rather than consumption of water. This is because steel works, as well as practically all other industrial plants, mainly utilize certain properties of water rather than consume or "use-up" the element. The repeated use of water in one form or another is practiced to a large extent at every large steel plant.

It is estimated that less than 1000 gallons of water per ton of finished steel, or only about two per cent of the circulated supply, is not returned by a steel plant through its sewers to the drainage basin in which it is situated. This small difference between abstraction and discharge represents evaporation, drift and other dissipatory losses. Paradoxically, it is in the plants that are obliged to recirculate the most water that the net water consumption (that is, dissipatory losses) per ton of steel is greatest.

There is still another aspect of water use which must be clarified. You may have observed that figures have been given in terms of "circulated" or "used" volume of water. By this expression we have tried to account for re-cycled water, that is, water supplied to certain parts of the steel plant that has already been used elsewhere within the plant for another purpose.

The steel plants situated on the Great Lakes have a practically unlimited supply of good water; nevertheless, even they use some of their water repeatedly. This may be limited to recirculating the water discharged from the condensers of the turbo generators and blowers to cool the blast furnaces. Part of this discharge from the jackets of the blast furnaces is usually re-pumped for use in the gas washers.

A few examples of water conservation as practiced by steel plants where the source of supply is limited will now be given:

a. At the Fontana Works in California, wells with a limited capacity, constitute the main source of supply. The total circulation is about 30 to 40 times as large as the "make-up" supply. This must be accompanied by the successive treatment of wastes and of passage of water through cooling towers. When we discuss distribution systems, a flow diagram will show how that has been done.

b. At Geneva, Utah, an entirely different solution was adopted. Here, the discharge of all clear cooling water is recirculated through a large lake wherein the water is cooled by natural evaporation to a temperature of 60 to 65 F after traveling two miles between the points of outfall and intake. The "make-up" is about 10 per cent of the volume circulated and comes from wells, springs and small streams. Most of this water, in the form of a blow-down, is eventually discharged and used for irrigation.

c. At Sparrows Point, Maryland, the problem was met by developing supplementary sources of supply when it was found necessary to reduce the abstraction from the fresh water wells. An additional supply from the water system of Baltimore or from other sources was not available. For these reasons, the brackish water from the Bay is used

extensively for many cooling purposes. However, it was found unsuitable for the cooling of rolls and for sprays. For these purposes, a novel project based on utilizing reclaimed Baltimore sewage was successfully developed.

d. Still another form of economy in the use of water, which in this case might be called "forced", is to be observed in several river basins. Steel plants strung along the Monongahela, the Ohio and particularly the Mahoning Rivers successively utilize the discharges from the up-stream plants. In the process, the water, at least in part, has undergone some treatment within the plants. At Youngstown, the entire discharge of the Mahoning is repeatedly passed through the steel plant pipe networks. As a result, in summer the temperature of the river rises to over 100 F. It is a tribute to the steel plant operators that this handicap is somehow overcome. However, it may be noteworthy that an analysis of operating procedures and records of some of these plants shows exceptionally large unit circulation rates.

STEEL PLANT WATER SYSTEMS

Water systems of steel plants can be studied from several different points of view, such as:

a. Quantity and quality requirements.
b. Sources of supply (water abstraction) and pumping facilities.
c. Distribution networks.
d. Recirculation.
e. Special treatment for certain uses.
f. Sanitary system.
g. Disposal of the spent water.
h. Problems of operation and maintenance.
i. Engineering for expansion and improvements.

All of these various phases cannot be covered in the limited time available for this paper. Water requirements and utilization of available supplies have already been discussed; therefore, the second half of this paper will briefly review a few special aspects; namely:

a. Quality of water.
b. Water intakes and pumping stations.
c. Distribution networks.
d. Engineering for expansion and improvements.

a. *Quality of water* — The quality of water required varies with the proposed use as previously noted. By far, the greatest part of the water circulated is for general cooling purposes throughout the plant. The quality of cooling water used in closed systems is not of too great importance, provided it is not too hard, that is, does not contain an excess of dissolved solids such as lime and magnesium carbonates and bicarbonates, or has too much matter in suspension. The danger in both cases is that the materials in the water would, on heating, precipitate out and adhere to the walls of the equipment, thereby affecting heat transfer efficiency and eventually plugging water passages.

Generally, and if the water is not excessively hard, where treatment is required, it need consist of merely occasional shot chlorination to inhibit the formation of slimes.

If the source of supply is limited, the water is recirculated through cooling towers, spray ponds or evaporating ponds and lakes are used, and only the make-up need be treated.

In other cases, salt or brackish water is used for these cooling operations. In such cases, special materials must be employed in the piping systems and the heat exchange equipment to resist the danger of corrosion caused by salt water.

Among the largest users of water are the blast furnaces. The cooling water for the furnaces and for gas washing does not have to be of high quality. As mentioned previously, it frequently comes from the discharge of the condensers of the steam turbogenerators and blowers.

Water used by the hot mills is primarily for cooling the reheating furnaces and rolls and for sprays that remove and transport the scale. Ordinary service water is usually satisfactory. The amount of suspended matter must not be excessive for the water used by high pressure sprays and the hydraulic systems, as sediment will clog the nozzles or harm the cylinders of high pressure pumps. Treatment of water used for such purposes may be required.

The portion of the supply used for cold rolling mills, electrolytic tinning, galvanizing lines and various other finishing operations requires relatively clear and pure water. For such applications, if the raw water is poor in quality, it has to be improved.

At the Fairless works a separate 15,000,000-gallon per day groundwater system supplies the sheet and tin mill. Ordinary service water, taken directly from the Delaware River is used by the hot mills.

Boiler make-up water almost always requires elaborate pre-treatment and strict quality control. There is already such extensive literature on this subject that to discuss it in this paper would be superfluous.

The quality of water for drinking use must also be good and strictly controlled. The boiler feed and potable water requirements being relatively small, that is, about 2 per cent of the total, they can best be met by purchasing water from a nearby municipal system. Sometimes, such a municipal facility is not available or is inadequate for the purpose and then a separate water system may be required.

b. *Water intakes and pumping stations* — The amount of water abstracted from the primary source (river, lake, estuary or underground reservoir) is always less than the total used or circulated through the various networks of a steel plant. If a sufficiently high degree of recirculation and repetitive waste water treatment is used, the primary source may be just a few wells, or a connection to the adjacent municipal system. In most cases, however, the integrated steel plants use large water abstraction facilities.

Each water intake project involves one or two dominant considerations that reflect the physical conditions governing the source of supply, and which result in determining the general type of installation required.

Such design factors may be widely varying river stages, ice formation in winter, strong wave action, floating debris, fish, heavy silt laden flows, special requirements for flexibility of operation and provision for recirculation.

In laying out water intakes and pumping stations, one of the principal decisions consists in choosing the type of pumps to be used.

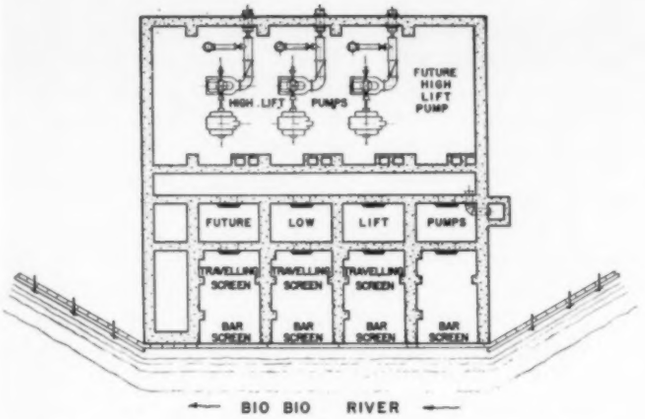


Figure 2 — Plan of pumping station built for Cia De Acero del Pacifico, at Concepcion, Chile. (Design Pat'd).

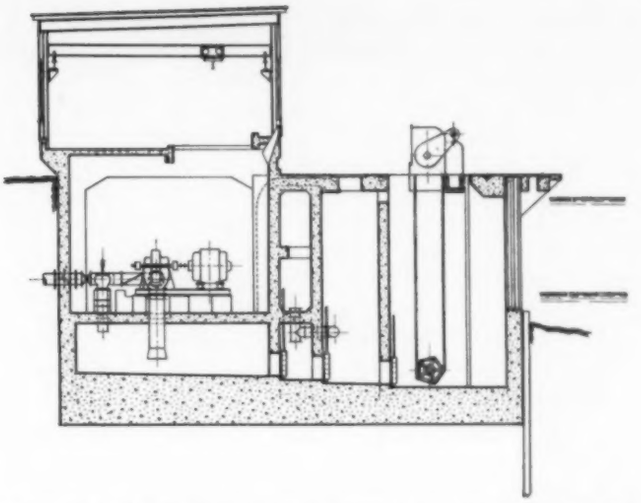


Figure 3 — Section of pumping station built for Cia De Acero Del Pacifico, at Concepcion, Chile. (Design Pat'd).

Most of the pumps now being installed in water intakes are electrically driven. The first thing to determine is whether they are to be horizontal or vertical units. The relative advantages of each type are as follows:

Horizontal centrifugal pumps and electric motors are cheaper, of sturdier construction, easier to inspect and maintain and are slightly more efficient than vertical pumps.

Vertical propeller, mixed flow, or centrifugal pumps require much less space and if the outdoor type of vertical pump is used, the housing or superstructure can be omitted. These factors, together may result in large savings in cost. In addition, vertical pumps require no priming, the danger of cavitation is considerably less, they are better adapted for widely varying water levels, and permit placing the electric motors above the maximum possible flood stage.

There can be little hesitation, for instance, where the river stage varies as much as forty or fifty feet. Vertical pumps placed in a caisson type intake are preferable. For lake intakes having a small variation in water level, requiring a simple structure and where very large volumes of water are to be handled, horizontal pumps may be more economical.

More frequently, a choice can be made only following analysis of alternate schemes. The following specific examples of intake design are indicative of the wide range of the determining factors.

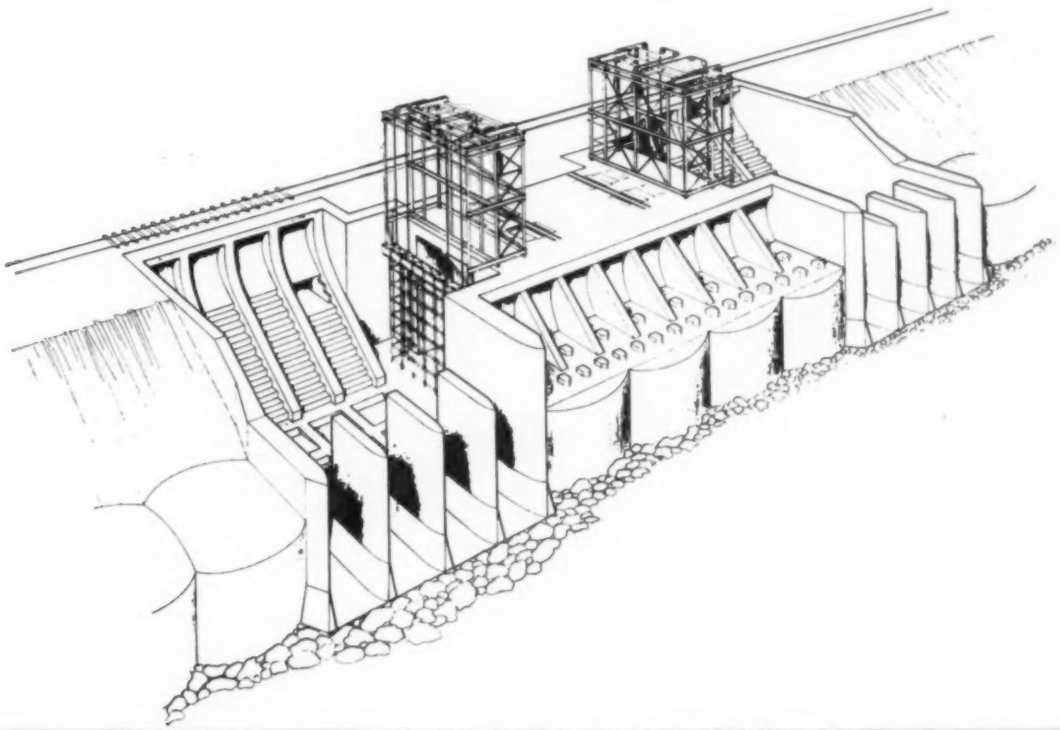


Figure 4 — Proposed water intake has been designed for use on a lake site. Capacity 400,000 gpm. (Design Pat'd).

SHALLOW RIVER INTAKE

The Chile steel plant intake and pumping station represents an interesting but rather special case where the extreme shallowness of the river and large quantities of rolling sand were the obstacles to be overcome. The Huachipato Steel Plant with a single blast furnace at Concepcion, Chile, built in 1947-1950, requires a present supply of 30,000,000 gallons per day. The most suitable source was the Bio-Bio River some five miles to the

south. The difficulty was that the river has a very wide and unstable bed composed of quicksand, and it was impossible to go out to the main channel. During the dry season, for months at a time, the depth of the northern branch of the river at the nearest relatively stable bank is only about one foot. Moreover, round shaped volcanic sand, having a relatively low specific gravity, in enormous quantity (about 8,000,000 tons per year) is carried in suspension and rolled by the current throughout the entire width of the river. Figures 2 and 3 show the design which was adopted.

The station contains three service pumps, one of which is a spare and space for a fourth service pump in the future. These discharge into a pipeline that feeds an open reservoir located on top of a hill adjacent to the steel plant.

Water is drawn from the river over adjustable sills and through bar racks. Space was provided in the station for the future installation of traveling screens and these were installed in 1951. Space was also provided for installing low head pumps to lift and circulate the water through adjacent settling basins before pumpage to the plant, in case such sedimentation is later found desirable.

As a further safeguard against sanding up of river channel and intake, a specially designed 6-in. river dredge was provided. This dredge can be used to remove shoals from in front of the intake and to maintain flow channels toward the intake through the shifting sands of the river bed.

LAKE INTAKE

An entirely different problem has to be faced by plants situated on the Great Lakes in this country. The

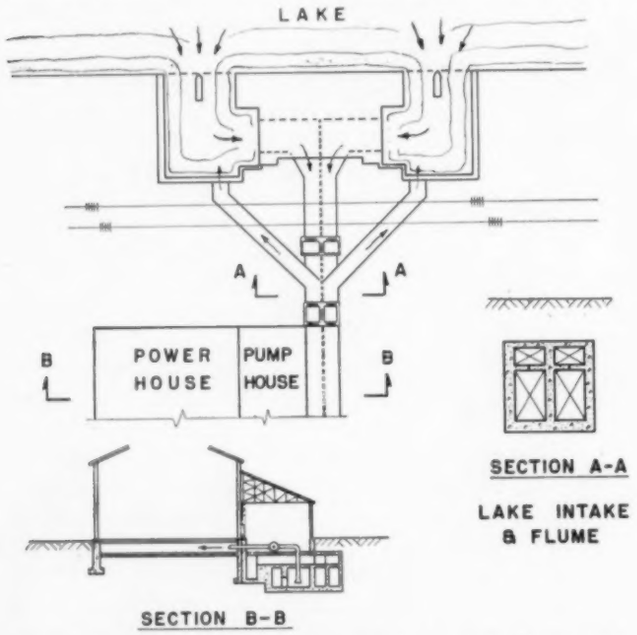


Figure 5 — Details of proposed water intake from lake source are shown in this view.

difficulties there can be summarized in three words: waves, ice and fish. For the larger steel plants, the problem has so far been met by building elaborate offshore island type intakes or submerged cribs. In both cases this has required constructing sub-aqueous tunnels, the costs of which are very high.

Where the fill is far out into the lake and the quality of the water is good, a different and much more economical solution has been worked out as shown on Figure 4. The design permits the intake to be mainly constructed behind an existing sea wall composed of cellular caissons. Ice piers, are provided, and a series of step baffles and a roll back type of sea wall will serve to break up the force of the waves. Electrically charged fish screens are to be installed in the forebay lagoons in a protected position at right angles to the face of the lake bulkhead.

Such an intake may have a capacity of 400,000 gpm and could be connected to the pumping station by a very large four-barrel, two-level flume. The two upper and smaller barrels will be used in winter to return warm condenser water to the two forebays of the intake ahead of the fish screen, thus preventing trouble from icing (see Figure 5).

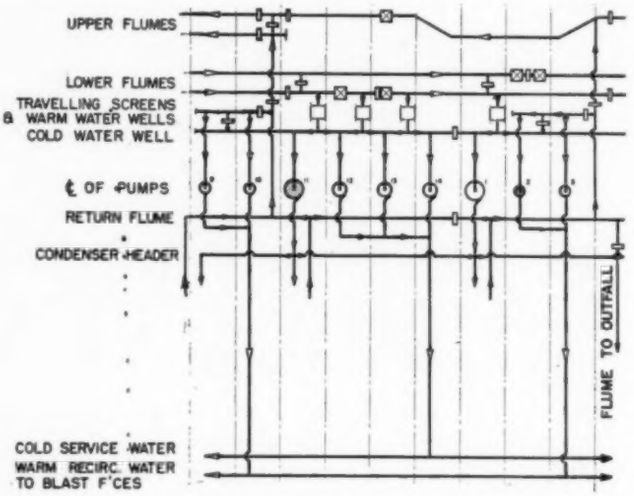


Figure 6 — Pumping station arrangement provides for great flexibility of operation on lake intake unit.

A diagrammatic arrangement of a section of the proposed pumping station adjacent to the power station is shown on Figure 6. Besides the pumps, the station would contain traveling screens, various flumes, and flow directing gates that provide for great flexibility of operation. The horizontal centrifugal pumps are planned to have capacities of 40,000, 30,000, and 20,000 gpm each and will supply the condenser, service and recirculating water systems respectively. All have electric motors, but one-fourth of the units would have alternate steam turbine drives for use as desired. The total pumping capacity of the station would be over 600,000 gpm.

DEEP RIVER INTAKE

Everybody is aware that on the Ohio River and some of its tributaries, the extremely high flood stages present serious problems. So far, they have been mostly solved by building massive caisson type intakes, placing horizontal pumps at the bottom, and carrying the walls of the structure above maximum flood level.

A different design has been worked out by us based on employing vertical type pumps which is shown on Figure 7.

Except for a project based on these principles which is now being worked out for the Newport Steel Corp. to abstract makeup water from the Licking River, as far as we know, steel plants have not yet used this type of intake.

For locations having wide river level variations, it is

recommended for future consideration. Two such units with a combined capacity of over 100,000 gpm were designed and installed for the Buckeye Ordnance Plant during World War II at South Point, Ohio. They are now successfully serving a chemical company that purchased the plant after the war.

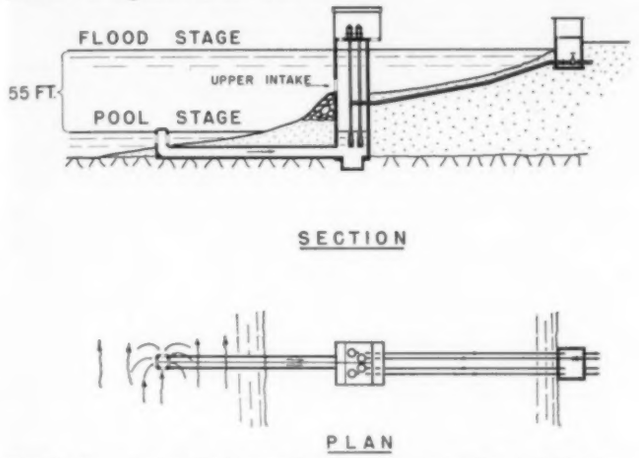


Figure 7 — Drawing shows design proposed for duplex type water intake for river with a high flood stage. (Design Pat'd).

FAIRLESS WORKS INTAKE

An example of an intake and river pumping station that incorporates unusual facilities for flexibility and reliability of operation was recently designed for the Fairless Works.

A perspective view of this intake and pumping station, which is located on the right bank of the Delaware River, is shown on Figure 8. The ultimate capacity of this station is 400,000 gpm when all ten bays will be equipped. At the present time, just the first half is constructed and operating. While the omission of housing

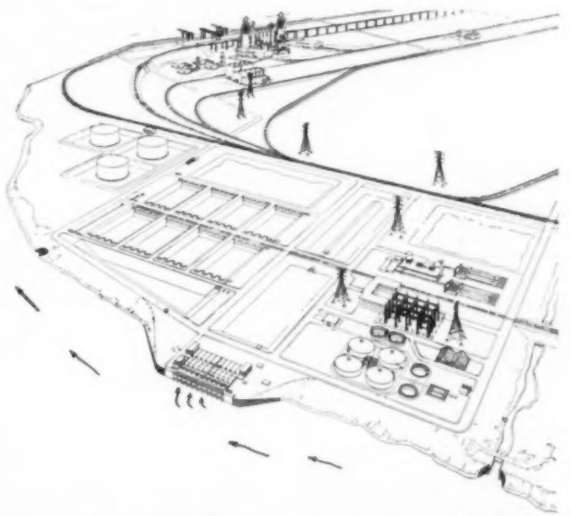


Figure 8 — Perspective view shows intake and pumping station for the Fairless Works of the United States Steel Corp.

for pumps is a common arrangement for condenser water pumping stations for steam power plants, it is probably the first time such a large outdoor installation is used for an integrated steel mill.

The special cellular design permits a number of different procedures for abstracting, straining, pumping, recirculating and distributing the supply. Not all of these are essential now, but provision is thereby made for various possible future contingencies.

Two means of drawing water into the station from the river have been provided. The first is over adjustable sills located at the river face of the station and through bar racks. The second is through deep off-shore intake cribs with self-contained bar racks.

A sectional isometric view of the station is shown on Figure 9. After entering the station forebays, the water passes through traveling screens and into the low lift pump well. The present low lift installation comprises six propeller type vertical pumps, the main units having a capacity of 45,000 gpm each.

The low lift pumps discharge through a four-barreled flume to a 12,000,000-gallon reservoir which is used both for settling the water and for storage.

Water for condensers and turboblowers is sent from the reservoir to the power house through a 72-inch

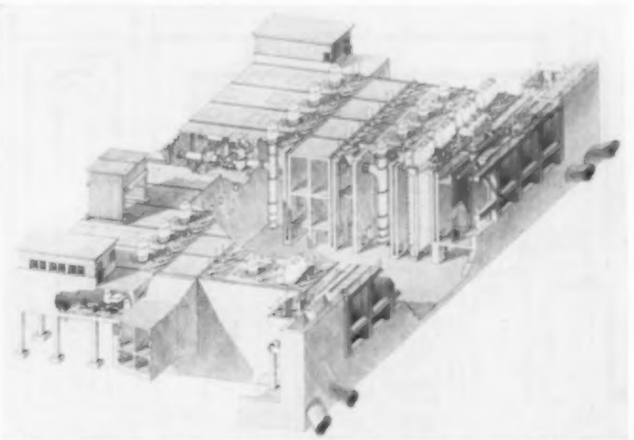


Figure 9 — Sectional isometric view of river pumping station at Fairless Works shows flow of water. (Design Pat'd).

diameter concrete pipeline under gravity flow. Two 35,000-gpm horizontal, centrifugal pumps driven by steam turbines are installed at the power house for "floating" on the service system and for emergency use in event of electrical failure at the river pumping station. In addition, this arrangement makes the looped water main system more effective.

Water is returned from the reservoir through the two upper flumes to the service pumps in the river station. The present installation consists of four vertical turbine pumps of 25,000 gpm each and two smaller units located together in the fifth bay. The service pumps can also be fed directly from the river. The service water system is designed for a working pressure of about 60 psi.

All pumps at the river station are electrically driven, and most regulation is done at the central controls building which also contains sewage and wastes treatment controls and a water supply and wastes laboratory. The station is designed to be fully automatic when the steel plant will be in full operation.

Figures 10 and 11 show, in addition to the river pumping station, the central controls building, the 12,000,000-gallon reservoir, the transformer yard, the sewage treatment plant, the terminal wastes treatment plant and some settling lagoons. The outlet from the lagoons is provided with facilities for recirculating clarified waste effluents through the service water supply when desired.

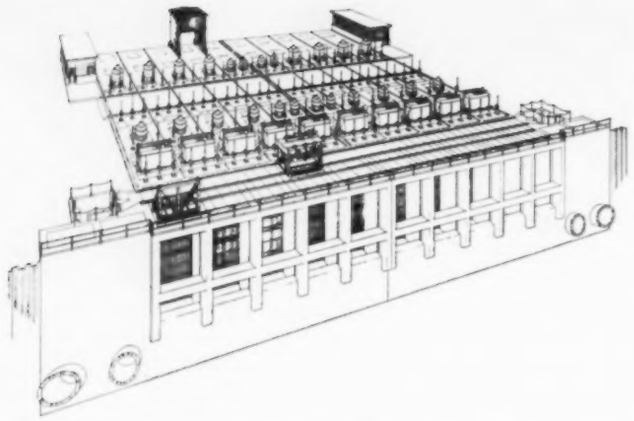


Figure 10 — Outside view of river pumping station at Fairless Works. (Design Pat'd).

mills and steel end product manufacturers depend entirely on the municipal supply or on well water.

The radial collector or well is advantageous when it might otherwise be necessary to construct a group of relatively shallow wells to develop the desired quantity of water. One collector replaces a number of vertical wells. It can also develop a much larger supply from a limited area. The radial collector is economically limited in depth to about 200 feet. The Granite City Steel mill is entirely supplied by three such horizontal wells.

Collectors form a very satisfactory method of securing water by infiltration from a river or lake. The Fairless Works has three such collectors installed. Two units furnish water that is of better quality than raw river water to the sheet and tin mill and one unit supplies the sanitary system. These units are now interconnected to supplement each other as operating conditions may make it advisable.

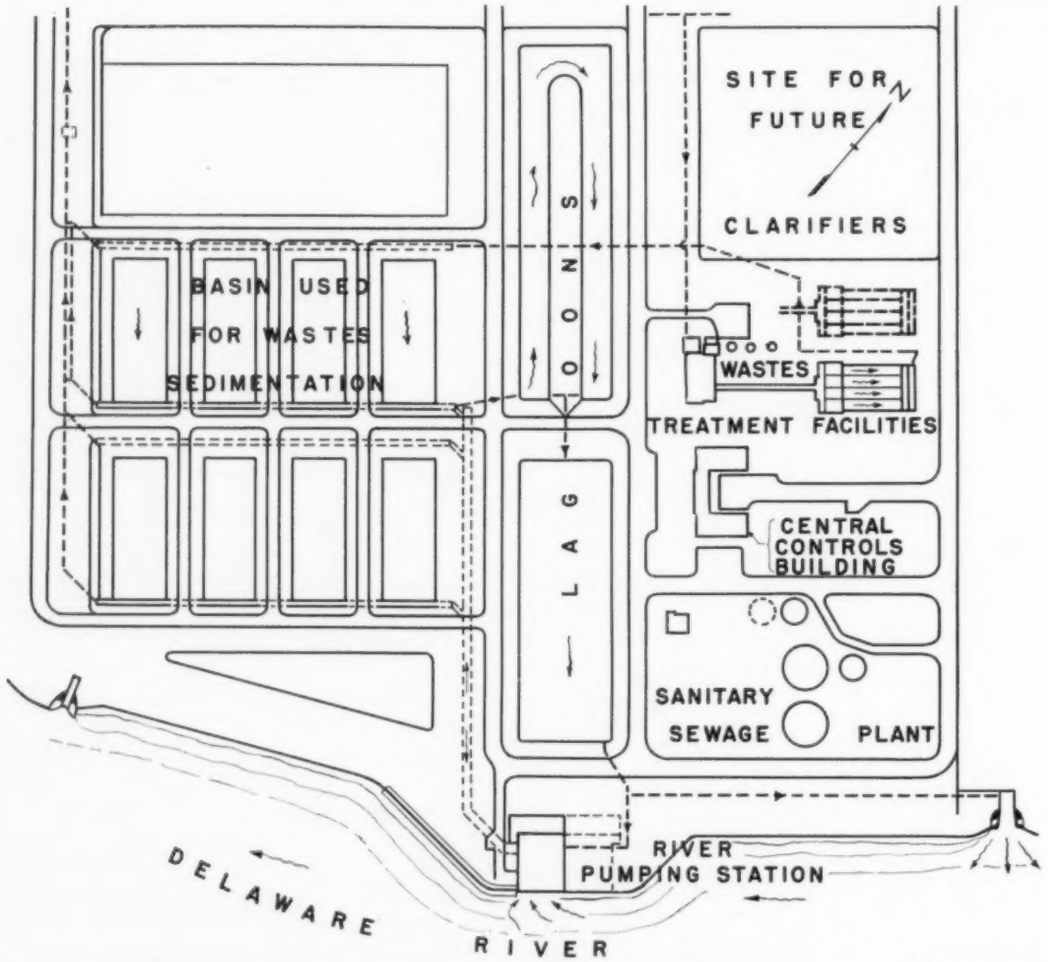


Figure 11 — Layout of Fairless water and waste treatment plants show that clarified waste effluents may be recirculated through the service water supply when desired.

GROUNDWATER ABSTRACTION

Two principal types of works for the abstraction of groundwater are as shown on Figure 12.

Vertical wells can be constructed to depths of 1000 feet or more and when sub-surface geology is favorable, yields range from 500 to 2000 gpm. Vertical deep well turbine pumps should be utilized when pumping water level is within about 250 feet of the surface. When the pumping water level is deeper, vertical turbine type pumps with submersible motors may be required. Of the larger integrated steel mills, only Fontana depends primarily on wells. However, quite a few of the smaller

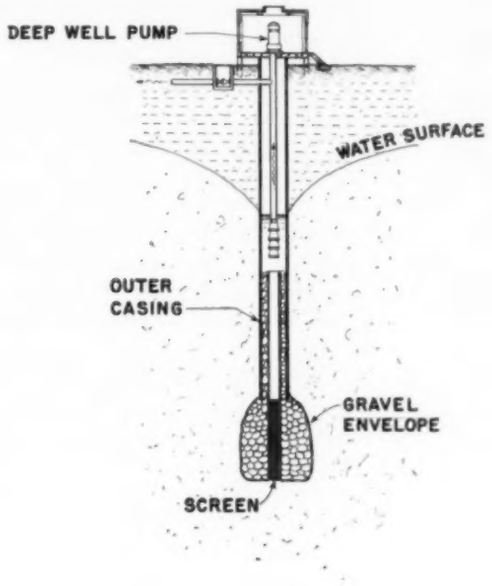
c. *Distribution systems* — Large steel mills always have more than one distribution system. Some of these may be completely or partially separate and others are of the subsidiary variety. As a guide in considering the problems of distribution, Tables III and IV list the water requirements of the main parts of an integrated steel plant.

The consideration of the water requirements of the particular steel making facilities would entail too lengthy a discussion of the various factors involved. There is a surprising variation in rates of circulation required by the respective steps in steel production.

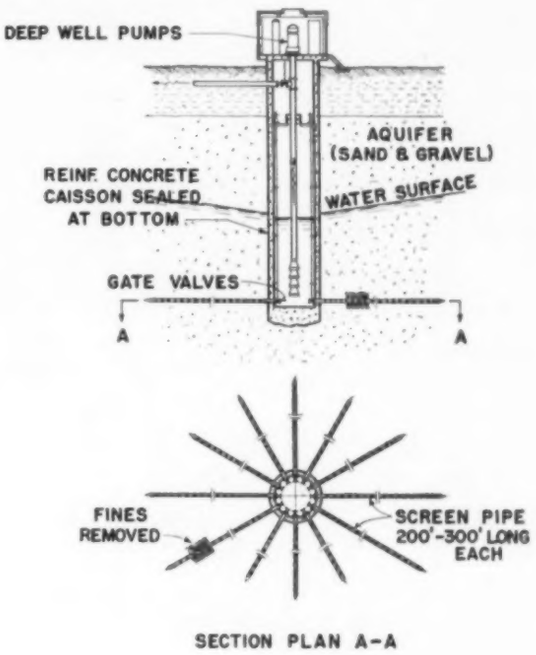
Table V indicates the wide range in such unit rates for each particular operation.

The distribution networks usually comprise at least five or six distinct piping systems:

1. The cooling or condensing system carries large volumes of water at low pressure to condensers and blowers.
2. The service water system carries large volumes of water under higher pressure, usually 35 to 55 psi pumps it at service pressures for use in cooling blast furnaces, etc.
4. The potable or sanitary system distributes small quantities of high quality water throughout the plant for drinking fountains, wash rooms, showers, etc.
5. The boiler feed water system supplies a small quantity of specially treated "make-up" water for use in the boiler plant.



TYPICAL GRAVEL PACKED WELL



TYPICAL RANNEY COLLECTOR

Figure 12 — Sketch shows two methods of collecting ground water. Both are in use at steel plants.

to furnaces and rolling mills and for general use throughout the plant.

3. The recirculating system uses as a source of supply the discharges of condensers and blowers, and

TABLE III

Water Requirements of Main Departments of a Modern Integrated Steel Plant

(Assuming a balance production of various types of finished steel)

	Per ton of finished steel	
	Volume of water in gallons	Per cent of total
Blast furnace area (including flowers, furnace cooling and gas washers)	10,000	25
Open hearth area	5,000	12½
Coke plant area	5,000	12½
Hot mills and related processes area	10,000	25
Finishing mills and related processes area	8,000	20
Sanitary, boiler, make-up and miscellaneous	2,000	5
Total	40,000	100

Note: The figures apply to a ton of finished steel and not to the respective intermediary production tonnages.

TABLE IV

Approximate Water Requirements of a 1,000,000-Ingot Ton Integrated Plant

	Normal operation, gpm	Emergency requirements for protection, gpm
Blast furnaces	9,000	7,200
Coke ovens	10,800	5,400
Open hearths	12,500	12,400
Slab mill	8,500	4,000
Hot strip mill	21,000	10,500
Continuous pickler	1,500	.....
Cold mill	1,000	.....
Cleaning line	100	.....
Annealing — batch and continuous	2,800	1,360
Atmosphere gas	750	750
Tin temper	150	.....
Electrolytic tinning	2,800	.....
Sheet temper	50	.....
Waste acid disposal	90	.....
Air compressors	140	140
Sanitary	150	150
Fire protection	4,000	4,000
Boiler make-up	1,100	1,100
Blowers	16,000	8,000
Condensers	40,000	.....
Miscellaneous coolers	500	.....
Total	133,000	55,000

TABLE V

Use of Water in Steel Plants per Unit of Product

Facility	Unit of product	*Gallons of water used per unit of product	
		Low	High
Blast furnace	Ton	1,200	27,500
Bessemer	Ton	180	4,400
Open hearth	Ton	850	9,350
Electric furnace	Ton	3,900	21,000
Soaking pits	Ton	80	1,400
Blooming mill	Ton	600	4,000
Billet mill	Ton	1,200	1,600
Bar mill	Ton	2,150	12,500
Hot strip mill	Ton	650	11,500
Skelp mill	Ton	3,500	7,700
Welded tube	Ton	1,350	8,400
Seamless tube	Ton	4,400	6,200
Round mill	Ton	8,700**	
Rod mill	Ton	7,600	4,200
Wire mill	Ton		25,000
Tin plate, hot dip	Ton	475**	
Tin plate, electrolytic	Ton	2,700**	
Cold mill	Ton	140	400
Continuous pickler	Ton	140	500
Turbogenerator	Kwh	40	180
Turboblower	1000 Cfm	60	270
Coke plant	Ton coke	130	310
By-products	Ton	1,600	3,800

* Note the wide variation between high and low figures. Data from 16 integrated plants was used in compiling the table. Differences in reported use are believed due to:

1. Variation in temperature of water.
2. Difference in design of equipment.
3. Water conservation and recirculating practice.
4. Differences in method of reporting water use and whether or not auxiliaries are included in figures reported.
5. Inaccuracies in estimating use by operators.

** This facility was included in the report of a single plant. Therefore, high and low figures are not available.

6. The hydraulic systems carry water under very high pressures to sprays and other apparatus where this water is used as a source of power.
7. In addition, as mentioned previously, a separate distribution system of sediment free water may be necessary for the finishing rolls and processes in the sheet and tin mill areas.

The above list includes only the principal systems, where sources of water supply are ample. At plants where water conservation must be practiced, the number of systems may be greater to provide for repeated use or re-use of water after cooling or treatment.

An example of a highly integrated water flow diagram and distribution network is to be seen on Figure 13. This refers to the Kaiser Plant at Fontana, Calif.

A much simpler arrangement for plants on the Great Lakes where water is plentiful is shown on Figure 14.

Finally, a new arrangement of the system that provides for great flexibility of operation and provisions for recirculating clarified waste effluents is used at the Fairless Works and is shown on Figure 15.

In general, the design of water systems should provide the following safeguards:

1. Failure of electrical power at the pumping station must not endanger the steel making facilities of the plant. This is preferably guarded against by providing sufficient number of steam operated pumps on each system to allow an orderly reduction of steel production should a breakdown occur, and to permit keeping furnaces from overheating until the electrical troubles are corrected.
2. The distribution mains should be so designed that by means of loops, double headers, two-way flows, etc., a broken pipe can be shut down and the remainder of the system kept in operation during repairs.
3. In addition, connections to major equipment should be in duplicate from separate feeders so that a broken water main will not result in heavy damages to furnaces or equipment or excessive loss of production.

d. *Engineering for expansion and improvements* — The presentation made, while not complete, nevertheless, gives some idea of the complex nature of the water supply problems of steel plants and the large investments involved. In order to keep a sense of proportion, however, we must point out that even so, the capital cost of water supply installations, including subsidiary pipe networks, constitute only about 3 per cent of the total cost of an integrated steel mill. The total operating charges, including interest on investment, at two cents per 1000 gallons would average 80 cents per ton or just about 1 per cent of the cost of making finished steel.

The designing of water supply facilities for new steel mills presents many problems and difficulties; but in many ways, it is simpler than developing an economic water supply improvement program for a crowded existing plant.

Usually in such cases, steel production has already been repeatedly expanded and very little space is available for new underground installations. Furthermore, the additions and alterations almost always must be designed so as to permit their construction without interrupting manufacturing operations.

Experience has shown that such situations require systematic and careful preliminary analysis. Perhaps a brief description of the method of investigation may be interesting.

The first step is a complete search and study of all available data on all phases, including sources of water supply. Blueprints of existing facilities, including water mains, sewers, electrical ducts and building and mill foundations are used to prepare a series of maps and drawings which are checked by intensive field work.

Next, a survey is made of the quantities of water being used in the different parts of the plant and the flows through the principal mains and sewers. Flows in pressure mains are usually measured by means of recording pitometers; flows in sewers by current meters, weirs and gagings.

Once the location and sizes of mains have been determined, and the flows through them measured, flow and pressure loss diagrams are prepared, which indicate by width of line the quantity flowing, and by color, the velocity of flow.

Based on these diagrams, the size and best location for new interconnections and mains needed to correct system deficiencies are selected, and a similar diagram prepared to show how a system of larger capacity would function.

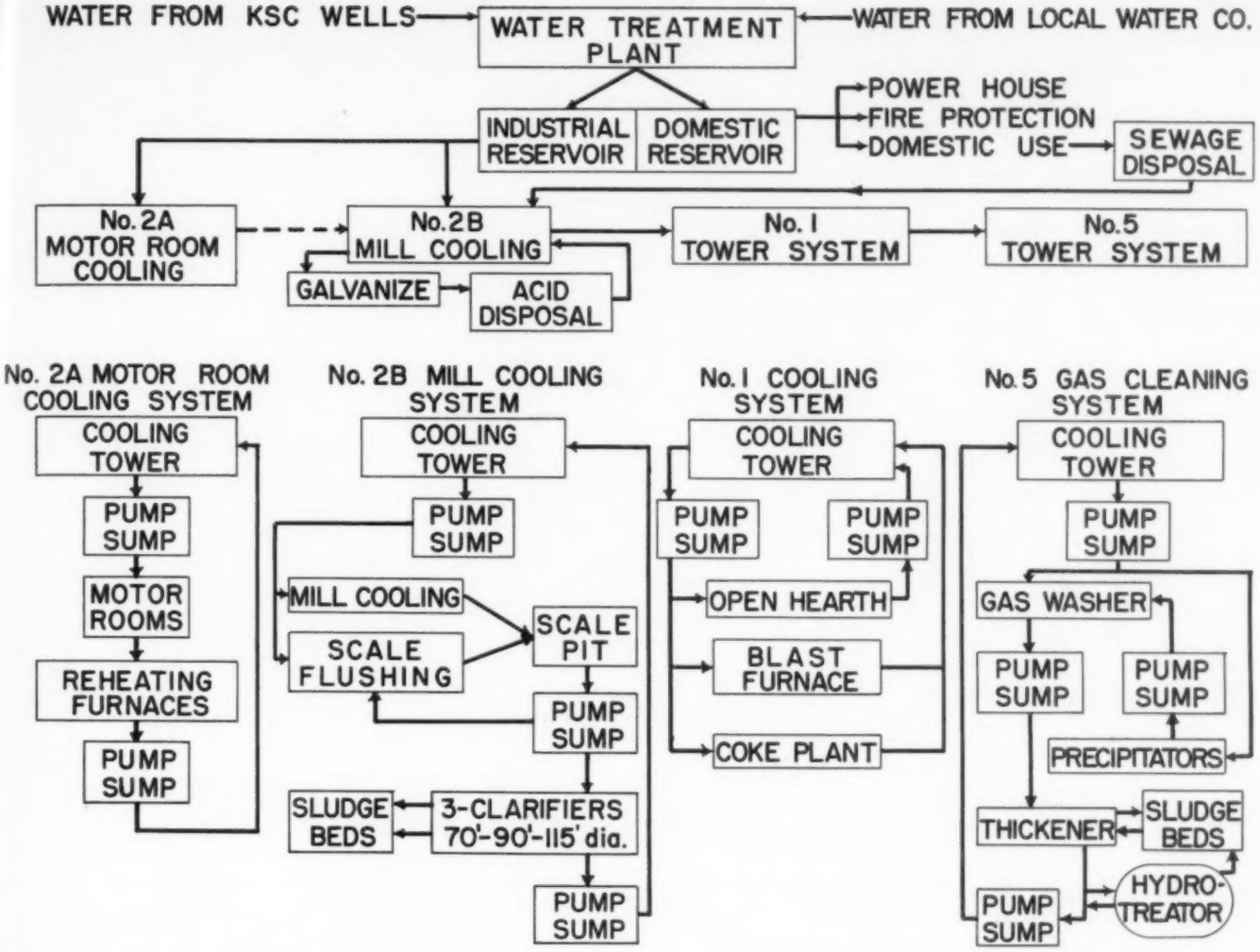


Figure 13 — Very effective use of water is accomplished at Kaiser's Fontana plant as illustrated by this flow diagram.

Then the route for the new mains is plotted on the maps, and the necessary field and office studies made to locate interferences of existing structures with the proposed new construction and to determine exactly where and how the installation can be made.

Finally, drawings and estimates of costs are worked out and, based on these, a comprehensive report covering a program of necessary improvements to be executed in several successive stages is prepared. This report can then serve as a practical guide to all future investments in this field.

It is hoped that this somewhat sketchy review of the

Figure 14 — Flow diagram illustrates water use at an integrated plant with an abundant supply.

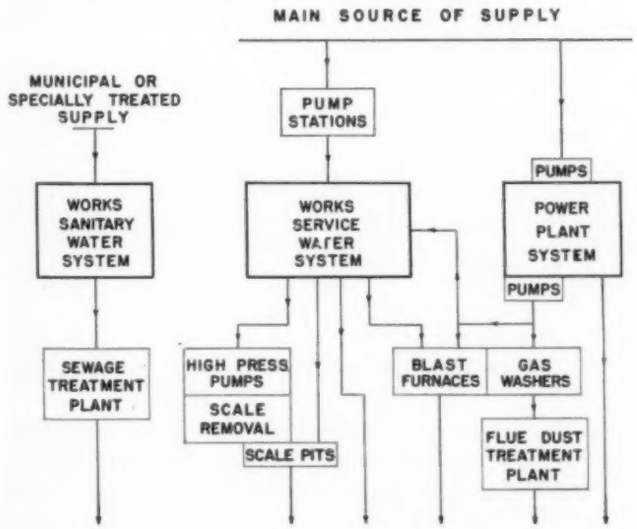
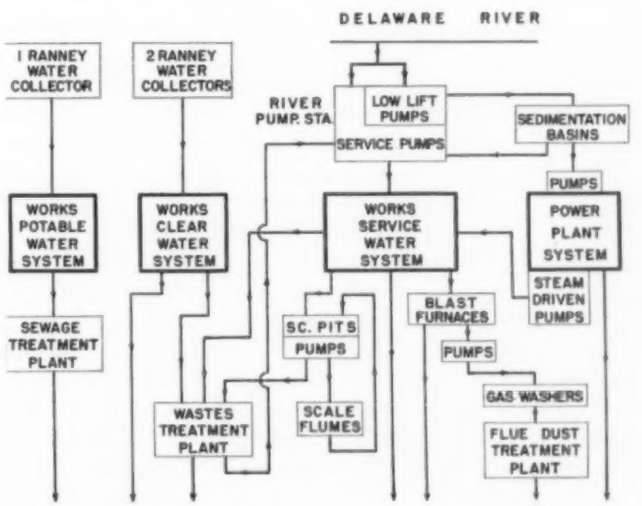


Figure 15 — Water supply systems at the Fairless Works provide for great flexibility of operations.



water supply problems of steel plants has at least given some idea of the complexity of their systems and the many factors which must be considered when designing needed improvements.

Cost of utility construction under the conditions existing in the older steel mills is high, but as steel plants continue to raise their production capacities, needed improvements to such an essential service as water supply cannot be allowed to fall behind.

DISCUSSION

PRESENTED BY

JOHN T. SEAMAN, Assistant Chief Construction Engineer, Construction Engineering Bureau, United States Steel Corp., Fairless Hills, Pa.

M. V. SWICK, Design Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

ROSS NEBOLSINE, President, Hydrotechnic Corp., New York, N. Y.

John T. Seaman: A word or two about the construction of the pumping station will be of interest. While this cellular type concrete structure is not unique, it did present some problems. The original elevation of the site was approximately zero, and of course was right at the river's edge. The area was covered with lily pads and very soft soil.

It was decided to build it "in the dry" and to accomplish this, a dike was built out into the river. The permanent sheet piling was then driven along its established line near the inside edge of the dike. By the use of pumps and a system of well point headers, the excavation was carried on in the dry to an elevation of minus 21 ft. At this elevation we were approximately 21 feet below mean tide.

Because of these problems, it did take us somewhat longer to build the station than was originally anticipated.

M. V. Swick: You mentioned chlorination for condenser water. Is there any other treatment for slimes? I understand there is a copper sulphate treatment. Is that applicable?

Ross Nebolsine: Copper sulphate needs more time for proper effect. It is usually used in reservoirs and in lakes, ponds and so forth. I think it has been used sometimes alternately with chlorine in closed systems, but you should watch the factor that more time is needed for the copper sulphate to have its effect.

M. V. Swick: One other question that I have is in the supply of condenser and blast furnace cooling water when recirculation is considered. I am particularly concerned with the recirculation of gas washer waste. Forgetting rise of temperature, what do you think should be the maximum amount of flue dust in recirculated water? I would like this figure in grains per gallon.

Ross Nebolsine: As far as I know, unless you have clarifiers, you certainly would not recirculate any of the gas washer discharge back into any part of the system.

M. V. Swick: I do not mean any direct gas washer waste, but effluent from thickeners that are clarifying gas washer waste that does get out into your water supply, resulting in a mixture of waste water and fresh water containing anywhere up to five grains per gallon of flue dust.

Ross Nebolsine: That is the standard figure to which most clarifiers now work. Where water is at a premium, such a reclaimed supply can be used. At Fontana, there is two stage clarification including chemical treatment which brings turbidity down to 2 grains per gallon. This water, after cooling, has successfully been used again for general service purposes.

At the Fairless Works we felt, and the U. S. Steel people agreed with us, that secondary clarifiers were necessary to be sure that the effluent would be satisfactory for discharge into the Delaware River. Now, that effluent of course could be recirculated, because the flue dust content in that effluent is down to about two grains per gallon.

M. V. Swick: You show fish screens. I know locally during the springtime we get runs of fish we call shad, and we have a great deal of trouble with them. How effective are the fish screens on that type of fish?

Ross Nebolsine: I am sorry I have no data on that. We have not too much direct experience with fish screens. We have observed fish screens operated by some of our customers, and none of them are fool proof, and none of them entirely satisfactory. That is why the intake I have shown you tries to provide better conditions for better operation of a fish screen.

M. V. Swick: The reason I bring that up is that the shad in the springtime are spawning, and some are half dead by that time, a good many of them die, and your fish screen would be useless.

Ross Nebolsine: The traveling screen is supposed to catch that. You see, it is the fingerlings that are supposed to be repelled by the electric current, but that is not always effective, either.

M. V. Swick: You show very large settling basins for pre-sedimentation. What would you recommend in an area where you do not have space available for large settling basins?

Ross Nebolsine: Most integrated steel plants do not use pre-sedimentation. We use pre-sedimentation at Fairless only because we at the same time obtained a reserve supply for the power plant. If you want to clarify or have to clarify and you have little space, then you have to use mechanical clarifiers where, by means of coagulation, you can get very effective coagulation with only a 30-minute retention period in your tank. That is about as low as you can go for complete clarification.

M. V. Swick: How about a mechanical strainer of an automatic type, or a series of them?

Ross Nebolsine: Some people like them and some people do not like them. They will not strain out the finer silt, you know. It would only strain out the sand and the coarser material, and then of course there is always trouble with that, and loss of pressure.

I would not care to comment further on that, because as I say, our experience is that most plants are dissatisfied with strainers as a primary water treatment facility.

M. V. Swick: What reserve pumping capacity over normal peak capacity is there at Fairless?

Ross Nebolsine: Based on the design requirements for the initial construction, there is approximately 30 per cent reserve capacity in both the low lift and service pressure pump installations.

INTEGRATED ELECTRICAL EQUIPMENT FOR BLAST FURNACE OPERATION

By C. P. HAMILTON
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. . . . the blast furnace is one unit in the steel plant which has gone far in the direction of automatic operation . . . .

▲ THE modern blast furnace uses such a large number of electrically operated devices that it seems appropriate to examine the over-all requirements in terms of an integrated system. In any continuous process, into which category a blast furnace can be placed, the reliability of the system, as well as of the essential drives, is of paramount importance. Loss of production, and possible damage to the furnace, as a result of an electrical failure, can be costly. Recognizing these important requirements, it will be the purpose of this paper to start with the power source for a typical installation and follow its distribution through to the various utilization components. Also in this review, the components in the system that will assure the greatest degree of continuity of service, safety to personnel, ease of installation, maintenance and fault correction, will be critically examined. Since a number of papers have already been presented on skip hoist drives and program controls, these portions of the system will be covered only to the extent of those points that are pertinent to the purpose of this paper. Also included are some new or novel schemes for skip hoist drives and program controls that have been placed into successful operation.

POWER DISTRIBUTION

A one-line diagram of a representative system is shown in Figure 1. The over-all installation can be no more reliable than the primary power supply. Failure of the a-c supply means that the furnace operation will have to be quickly retarded due to the lack of cooling water since the pumps are generally driven by motors from this same source of power.

The circuit shown makes use of two independent incoming feeders connected to a double ended load center unit substation located in the skip house. The skip house is a convenient location for any circuit switching that may be necessary. The source of power to the feeders should be as adequate as practicable, and the feeders should be provided with circuit breakers of ample interrupting capacity, well installed and protected against damage.

Each self-cooled transformer unit of the load center must have ample capacity to carry all of the essential loads, which in turn are split up between the two buses so that outage of one of the buses will not seriously

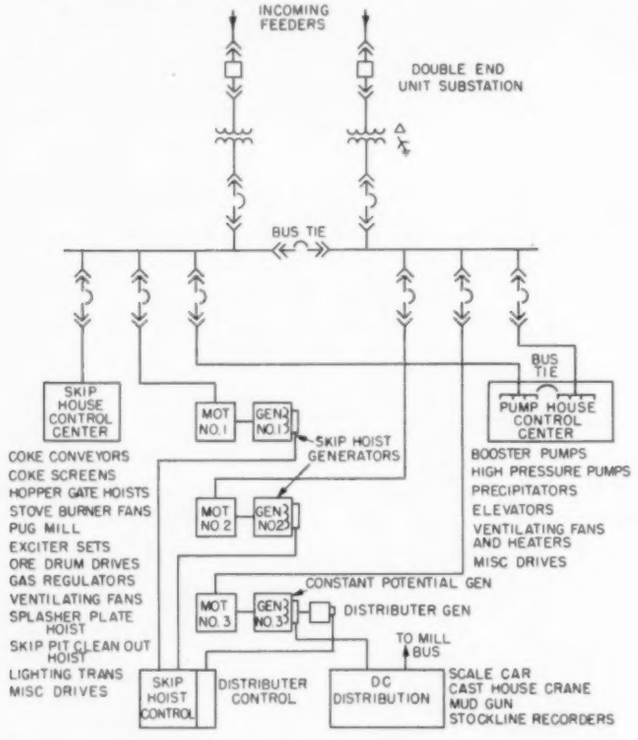

Figure 1 — One line diagram shows power and utilization circuits for typical blast furnace.

affect operation of the furnace. The breaker overload trips are arranged for selective operation so that the overloaded feeder will be the first to be taken out of the circuit. The bus tie breaker is normally open, and by means of key interlocking, this breaker can only be closed when one of the transformer secondary breakers is open, thus making it quickly possible to maintain operation of all essential machines from one transformer or the other. All switching of the secondary distribution circuits is located in the metal enclosed load center which is provided with drawout type breakers for quick maintenance or replacement. Neutral grounding of the transformer secondary reduces operating and maintenance expense, improves service reliability; provides greater safety to personnel and better system equipment protection.

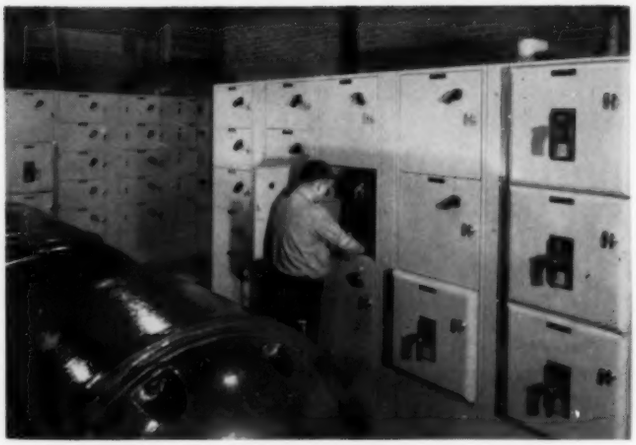

Figure 2 — Group assembled control centers are a logical answer on blast furnace installations.

To simplify the starting equipment, the load center will usually contain electrically operated breakers for full voltage starting of the hoist, and constant potential motor-generator sets and manually operated feeder breakers for use in the circuits to the motor control centers.

A similarly constructed metal-enclosed unit with drawout breakers is provided for the constant potential direct current generator and the feeder circuits to the scale car, transfer car, cast house crane, the mud gun, the distributor when operated from constant potential, and the stock line recorders.

POWER UTILIZATION

When it is realized that the number of individual power utilization units required for blast furnace operation can easily approach 50 or more, the need for a well coordinated motor control system becomes apparent. The use of group assembled control centers appears to be a logical answer, and a number of such units have been installed of the general type shown in Figure 2. Such units permit coordination of the control for selected groups of drives and for dividing the drives into essential and non-essential categories for circuit segregation in the distribution system from the load center. The use of the proper type of air circuit breakers or, of high interrupting capacity fuses, gives adequate circuit protection and localizes faults. The grouping of the controls into metal-enclosed centers with lockable doors and with air circuit breakers and switches, operated externally, reduces installation and maintenance expense, and minimizes the hazards to operating personnel. Control equipment of this character is well protected from dirt and construction hazards, particularly during installation, and tends to exclude the gases that are so prevalent after the furnace is put into operation.

ESSENTIAL DRIVE UNITS

A continuous supply of cooling water is required when a blast furnace is in operation. Figure 3 shows a typical pump installation. Damage to the furnace can

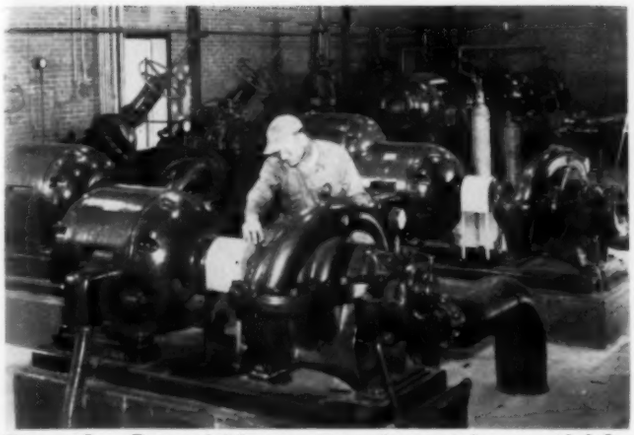

Figure 3 — Dependable pump equipment is essential for blast furnace operation.

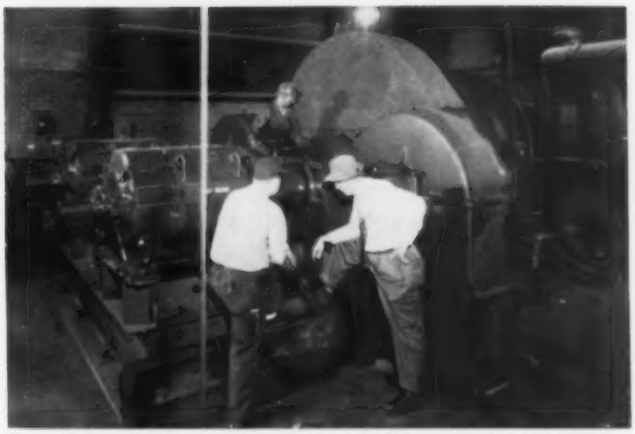

Figure 4 — Hoist requires dependable equipment to insure continuity of operation.

quickly result if the water supply is interrupted for more than a very few moments. The schematic sketch of the power distribution circuit, see Figure 1, includes two feeders from the load center connected from each transformer bus to the pumphouse motor control center. This control center includes a split bus arrangement which results in normally maintaining independent circuits to the two 200-hp pump motor starters. The two pump drives shown are practically separate systems from the pump to the incoming feeders with provision to change feeders through the bus tie in the motor control center or at the load distribution center.

Second in the category of essential drives is the skip hoist operating system. While no damage will necessarily result if the hoist operation is briefly held up, the furnace does depend entirely on the skip for charging. Continuity of operation is extremely important, and ample provisions to keep the hoist in service with a minimum of outage time are well justified.

The provisions for assuring continuity of operation of the hoist shown in Figure 4 include:

1. Two duplicate motor-generator sets, each fed from the individual buses in the load center. This permits operation of the hoist from one motor-generator set in case of a feeder failure, starter failure, or a driving motor failure.
2. Figure 5 shows the hoist is driven by two duplicate mill type motors connected in a series loop circuit with the two generators. Switching is provided which quickly permits a selected hoist motor and generator to be taken out of the circuit. The selection of the machines and design of the control will then permit running the hoist at approximately 75 per cent of the normal operating speed with the skips carrying the rated loads. This is accomplished by "forcing" of the motor shunt field excitation to obtain the high torque per ampere of armature current which is required to permit single motor operation without using unnecessarily large machines. In addition to the flexibility that is provided for continuing operation, the following advantages are also obtained:

a. By maintaining operation with normal skip loads the charging program is not disturbed.

b. The loading of the motor and generators is equalized by connecting the machines into a series loop circuit. The control design is greatly simplified due to the elimination of a number of large size contactors and relays. This is important from the standpoint of continuity of operation, ease of maintenance, and spare parts required.

This flexibility of the hoist system, which permits operation as long as an a-c power source is available, largely eliminates the necessity of making provision for operating the hoist from the d-c mill bus. A complete failure of the a-c sources would shut down the pumps which would require the operation of the furnace to be quickly curtailed. The exception would probably be in those installations that happen to have steam driven standby pumps that could be used to supply the furnace cooling water.

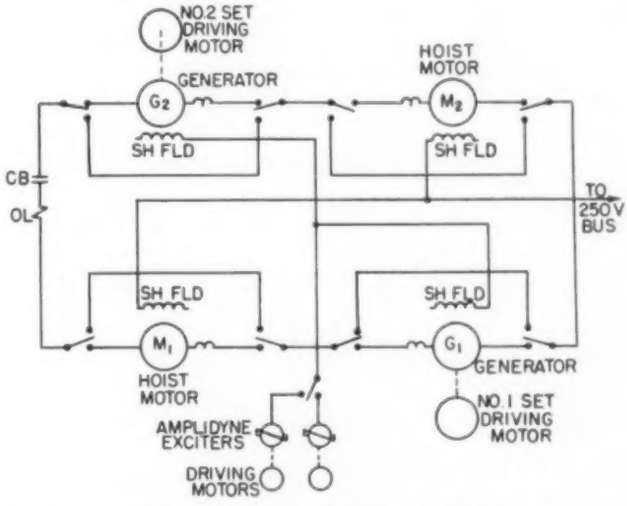

Figure 5 — Hoist is driven by two duplicate mill type motors.

In examining the electrical system for hoist operation further for possible vulnerable points, it will be found that the excitation system for the hoist motor and generator fields, for operation of the brakes and for the control devices, requires careful attention. Unless everything that affects continuity of operation is considered, the objective is defeated. Two sources of constant potential direct current are usually provided by the following means.

1. The use of a motor-generator set, preferably duplicate of the machine used for hoist service, and with provision to switch the circuit to a mill bus

if available. The use of duplicate machines simplifies the spare parts problem. Usually the hoist generator has ample capacity to take care of the requirements of the scale car, the transfer car, the mud guns, the cast house cranes, stock line recorder, and distributor if it is operated from a constant potential source.

2. If a mill bus is not available, switching may be so arranged that one of the sets, normally used for the hoist, can be used for a constant potential power supply.

Figure 6 — Program control is becoming a necessity in blast furnace operation.

When the generator fields are excited from a separate exciter, such as the rotating regulator, it is the practice to provide duplicate exciter sets with a transfer switch for the armature and field circuits. Such an arrangement is also advantageous from a maintenance standpoint, such as checking of brushes, without having to shut the hoist down during this period.

PROGRAM CONTROL

The use of a program control system for the modern blast furnace seems to be an accepted necessity since it largely eliminates the human element in preserving the charging sequence and loading, as well as saving labor.

The installation shown in Figure 6 includes a somewhat different type of program control and distributor operation than has been heretofore used, although ac-

Figure 7 — Operating panel is equipped with lights to give operator necessary data.

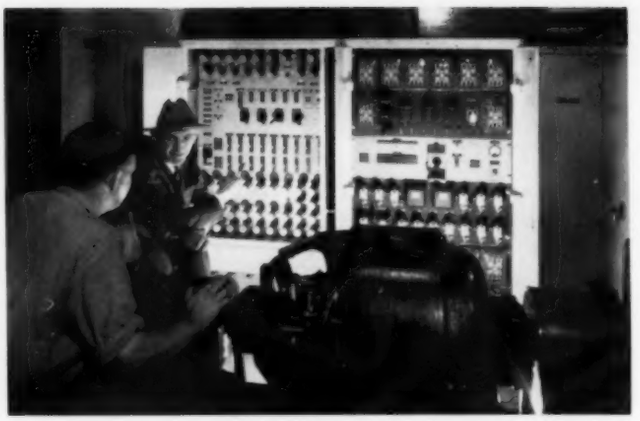

Figure 8 — View shows a novel blast furnace panel layout.

complishing the same end results. This program system differs largely in details and circuitry from those that have been described in previous papers presented before the AISE. The heart of such a system is largely in the devices used for counting and programming. For this particular system, stepping relays, an industrial design of a type similar to those in telephone exchanges, were used. This type of relay has a record for unusually long life and reliability. Its use for blast furnace programming is rather old, having been described in the July 1939 Iron and Steel Engineer, and having been used on another installation even previous to that time. The operator's panel shown in Figure 7, is generally arranged in a familiar pattern with its array of indicator lights to show stock line level, the distributor angle, the round in operation, and the skip num-

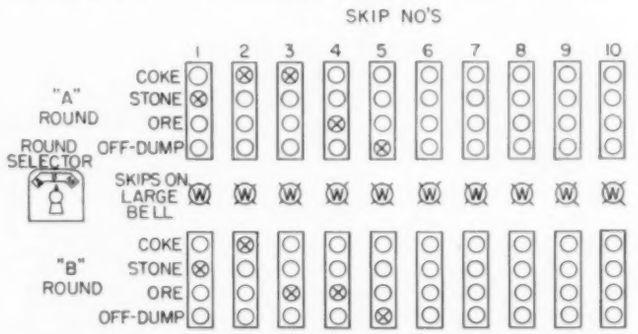

Figure 9 — Panel shown has two sets of stations one for the "A" round, the other for the "B" round.

ber being delivered in a round. A novel arrangement is shown on the main panel in Figure 8. Of particular interest to the operating personnel of the blast furnace, is the simplicity of setting up the round combinations. On the sketch shown in Figure 9 it will be noted that there are two series of push button stations, one for the "A" round and the other for the "B" round. To set up a particular sequence, these buttons are pressed in the order that the respective loads are to be delivered. In other words, if the round sequence calls for a stone load followed by two coke loads, and then an ore load, it is simply necessary to push No. 1 button for the stone load, No. 2 and No. 3 buttons for the coke loads, and No. 4 button for the ore load, and dump button No. 5 is pressed to end the round. A round selector switch is provided which permits alternate rounds be-

ng delivered to the distributor in sequence or either the "A" or the "B" rounds can be individually used.

Recognizing also that at some time in the operation it will be necessary to check the stepping relays or the memory relays, provision has been provided to include a spare relay of each type on the panel. These relays are connected by a type of plug so that they can be quickly removed from the circuit and the spare relay put into its place. The panel includes a checking section so that the replaced relay can be quickly plugged in and indicator lights light up for each circuit and each position of the stepping relays. An ammeter also shows whether or not the coil is defective.

DISTRIBUTOR OPERATION

It has been the usual practice to operate the distributor with a compound wound motor from conventional rheostatic control. A new system has been in operation at the Crucible steel plant since December, 1952, which has been very successful. This drive uses a shunt wound motor with adjustable voltage control rotating regulator system which is so connected, in combination with the program control, that the speed of operation is a function of the rotation angle. In other words, the operating speed of the distributor will be ½, ⅔, and full speed for rotation angles of 60, 120, and 180 degrees, respectively. This speed selection, as a function of rotation angle, results in approximately constant time for distributor operation regardless of the angle that the distributor is to rotate, and therefore, it is only necessary to simply select the time, which has a considerable range, so that it will not become a bottleneck in the overall charging of the furnace. Other advantages of this system are quicker and more accurate stopping of the distributor and also less wear can be expected because of the slower speed of operation for 66 per cent of the operating time of the distributor.

MAINTENANCE

Simplicity and flexibility in the power distribution and utilization equipment plays an important part in assuring continuity of operation, and a brief review of the provisions made in this direction is in order at this point.

1. Duplication of equipment is provided wherever practicable.
2. The use of drawout breakers in the load centers and removable starting equipment in the motor control centers makes maintenance and replacement quite simple.
3. Failures in rotating machines are extremely rare. Also, circuit failures should be quite infrequent when well installed. However, operating conditions around blast furnaces, such as the prevalence of conducting dust and sulphurous fumes from the slag pit, justify precautions being taken to protect the equipment, such as:
   a. Pressurizing the skip house.
   b. The use of cabinet-enclosed control equipment.
   c. The use of filled commutator risers for the generators prevents accumulation of carbon dust due to brush wear often aggravated by the fumes from the slag pit.
   d. Providing clean filtered air to the machines.
   e. The use of indicator lights to show the operating condition of machines, particularly those that are extremely important in the operation of the equipment. If a machine happened to shut down, it is advantageous to the maintenance personnel to be able to detect quickly which of the machines has shut down.
   f. The use of fault finding devices to search out or indicate open circuits, particularly those in interlocking circuits. The fault finding devices may be one of three different forms as follows:
      A. A multi-circuit switch with an indicator light to "feel out" an open circuit.
      B. The use of drop type indicators to show the location of a fault.
      C. The use of glow light type of fault indicators.

SUMMARY

The electrical equipment required for the modern blast furnace has become so comprehensive, and the operation so automatic, that the reliability of the whole system from the power sources to the utilization components is extremely important. It is necessary to start at the power source and carefully examine each component right down to the drive itself. This resolves itself into the following requirements for the overall installation.

1. Adequate power sources.
2. Flexibility in the distribution system.
3. Adequate interrupting rating of the breakers with selective tripping characteristics so that only the faulted section will be opened.
4. Flexibility in operation of all of the essential drives so that switching means and duplication will permit continued operation.

DISCUSSION

PRESENTED BY

JOHN R. GREEN, Manager Steel and Ceramics Div., Industrial Div., Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

HARRY H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

JOHN P. GRILLI, Consulting Engineer, John Mohr and Sons, Chicago, Ill.

J. RAYMOND ERBE, Senior Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

R. S. HURTT, Electrical Supt., Crucible Steel Co. of America, Midland, Pa.

WILLIAM B. FERGUSON, William B. Ferguson and Associates, Chicago, Ill.

C. P. HAMILTON, Application Engineer, General Electric Co., Schenectady, N. Y.

John R. Green: It is desirable to extend the precautionary measures to the process instrumentation and control such as hot blast and stove temperature and fuel-air ratio control. Wherever electrical systems are

employed, the power supply should be as uninterruptable as possible, with provision for manual operation at any time. When air is used as a control medium, additional assurance of continuous operation can be provided by an auxiliary electrically driven compressor.

A recorder on sequence of skip or distributor operation is an additional tool to identify or trace down irregular operation.

Harry H. Angel: About 25 years ago, while working at the Sparrows Point plant of the Bethlehem Steel Co., it was my good fortune to have worked with Mr. Hamilton in the installation and placing into operation of the first variable voltage skip-hoist control that was installed in that plant. Mr. Hamilton has stressed such items as reliability of power distribution, provisions for continuity of service, flexibility—and, of equal importance, the necessity of good installation, inclosure of all equipment, and pressurizing the skip hoist motor room to provide proper cooling and keeping out the dirt.

It has been my experience that few failures of hoisting motors and generators are encountered, but nevertheless, provision must be made for this condition. I know several installations where operations at 75 per cent or better of full speed may be obtained upon the failure of one of the duplicate generators or hoist motors.

Another installation uses a two-unit motor-generator set, with one generator, and two skip hoist motors for each of four or five blast furnaces, with a spare motor-generator set permanently installed so that it may be connected to replace any of the four or five units in a few minutes.

Another uses a combination of a motor-generator set for variable voltage control, and rheostatic control for constant potential operation of the skip hoist motors. This has proved to be of especial help when the rheostatic control was utilized to get the furnace started, before the motor-generator set had arrived. No spares are provided for the motor-generator set.

I would like to ask the author's comments on this question: Do many people use a combination of motor-generator set and rheostatic control?

The combination of skip hoist control and associated program controls produce an inherently complicated control, probably more so than that of a reversing mill. I am in full accord with Mr. Hamilton's suggestions of doing everything possible to safeguard equipment, and to provide various schemes to facilitate finding control trouble faults, thus making it easier for the maintenance men to reduce the furnace delays.

John Grilli: Continuity of service is a most important feature in the design of a modern blast furnace. In addition to providing alternate sources of supply for cooling water pump and skip hoist as mentioned, similar arrangements are made for the stove burners. Moreover, if the service water supply is lost, an automatic transfer is provided so that the gas washer pumps and sump tank will provide emergency cooling for the furnace.

As in all parts of the steel mill, the ever-present aim is for a better product and for more tons output. The selection of equipment, both mechanical and electrical, must be carefully integrated into the overall picture considering each function in relation to the others. Mr. Hamilton has pointed out how the skip hoist and distributor fit into the picture. He did not mention the important parts played by the motor driven ore drum gates which load the scale car at a rate of 1000 lb per second. The final weighing is accomplished by inching control which results in a weighing accuracy of plus or minus 50 lb. The coordination of the control sequence is accomplished by the operation of the program control, but the operator has complete liberty in setting up the most desirable cycle, the fastest charging cycle in most cases is not the most desirable cycle to use to obtain the best metallurgical results.

The result of this overall engineering is more controlled production. The charging equipment is designed for a capacity of 2400 tons of pig iron per day which a few years ago was merely a goal to shoot at. Attaining this goal is largely due to the fact that after a cast, the charging equipment, as mentioned in Mr. Hamilton's paper, will have the furnace back to normal stockline in 30 minutes. Four to five hours is not uncommon on some present modern blast furnaces on high wind. It has been possible to charge as many as ten charges per hour on this integrated charging equipment.

I believe you will agree that the blast furnace has kept pace with the progress being made all around the steel mill. We believe Mr. Hamilton has presented the part that the electrical equipment plays to attain this end in a very interesting and convincing manner.

J. Raymond Erbe: We believe that Mr. Hamilton has presented a clear and concise picture of what an ideal layout for the electrical equipment of a blast furnace should be. On a complete new furnace installation, serious consideration should be given to the features discussed in this paper.

We are also in accord with the statement that simplification increases the continuity of operation, reduces and makes maintenance easier, and reduces the spare parts required. In fact, we are continually striving for simplification of the various mill drives without sacrificing reliability of operation or the flexibility required to meet changing operating conditions.

Although quite valid reasons have been given for providing the ultimate in flexibility, there are other factors which must be given due consideration, especially when an existing skip hoist is being modernized. One point, in particular, is whether or not it is justifiable to provide two 2-unit motor-generator sets for operating the skip hoist as against one 3-unit set driven by a squirrel cage induction motor. This arrangement provides the flexibility of operation from one generator in an emergency, and depends only upon the reliability of the squirrel cage driving motor to provide the same continuity of service.

On a recent skip hoist modernization program we compared the cost of the motor-generator sets, adjustable voltage control, and motor-generator set starters for the 3-unit and two 2-unit motor-generator set arrangement and found the latter to be 20 per cent higher.

When consideration is given to the reduced space required by the 3-unit set with only one starter, especially if an addition would be required to the hoist house if the other arrangement were used, we believe the saving justifies dependence upon a single driving motor.

After all, as Mr. Hamilton has already pointed out, the entire furnace operation stops if the a-c power supply fails regardless of which arrangement is used.

R. S. Hurtt: The furnace control at Midland was taken from the one-line drawings of Mr. Hamilton. The new relaying program control was the first of its kind used. All the protection that he has mentioned was incorporated in our new furnace at Midland. There is just one thing that bothers us today, and that is we only have one power source coming in from Duquesne Light. We have contracted for the second line, with automatic throw-over between the two lines, to give us emergency power for our furnace operation.

All of the program control circuits were very good, as our operation has proven. When starting up the furnaces, we did run into a few troubles. We were able to raise the hoist and then empty the coke bin in the hole under the hoist, so we had to install some positive interlocking to prevent that. So with just a few minor changes in the circuit, we were able to set the hoist so that the right hoist, or skip, had to be down before the coke gate on that particular skip would open. Also, the hoist could not raise as long as the coke gate was open.

Another thing that developed, was that we could get more than one skip on the small bell at one time, or we could get more than one round onto the big bell before we opened that. That was re-interlocked so that we can only get one skip on the small bell before it opens, and one round on the large bell.

There is a possibility, with the manual control, when they want to change the sequence, you can add another skip of coke or ore, or whatever the operator desires, on the same round, and by this arrangement he can get more coke or ore on the big bell than should be at one time, so we may have to interlock to reduce the number of skips on the big bell before it opens.

The maintenance of our installation has been at a minimum. We have not had to changeover and run on one motor yet. It has all been tried out. I do not know of anything in the new circuits that should give us any trouble.

The only thing we had to do was put additional covers around the stepping relays, for they are very sensitive to even small particles of dust, and that interfered on starting up. But after the addition of separate relay covers inside the metal clad unit, we have experienced no more trouble with either the stepping relays or sealed relays in the program circuit.

Wm. B. Ferguson: First of all may I state that Mr. Hamilton has given a very complete coverage of the rotating regular skip hoist. I would like to make a few comments on a somewhat different type hoist control. Mr. Harry Angel has raised a question regarding the starting up of a particular hoist, may I correct one phase of that question by pointing out that the hoist in question is a combination series-parallel, variable voltage unit and not a rheostatic, variable voltage as mentioned. The hoist in question was started up when the furnace blew in and ran for some time as a series-parallel unit prior to the motor-generator sets arrival at the plant.

Those of us who have been very closely associated with skip hoists for the last several years feel very keenly the need for continuity of service where blast furnace operation is concerned.

I was formerly with a company which has built complete blast furnaces which of course involved the entire power source. We have attempted to integrate the power supply in such a way as to assure all the various functions about the blast furnace received the same consideration from the power standpoint. In this connection, the skip hoist has probably been given more consideration than any other appurtenance about the furnace.

Realizing that the average plant has a very firm source of direct current available at 230 volts, we have taken advantage of this fact and used the existing power source as a standby for the skip hoist operation. The primary source of power is a variable voltage motor-generator set.

First let us consider the inherent characteristic of a skip load which is a very high torque requirement to start with, a tapering torque requirement to accelerate, and a very much decreased torque requirement during running. To accomplish the very high torque requirement economically, one of two things must be done. We have to over-motor, or we have to take advantage of characteristics of a motor to best advantage.

By that is meant forcing the fields of the standard 600 or 400 series motor, as the case may be, in starting, in the following manner: The fields are wound for 75-volt service. They are then connected in series, which does two things, it gives you a better insulation factor, because of the fact that it is wound with No. 11 wire, and not some small wire such as 22 or 23. Secondly, it gives us about 11 per cent more torque than is possible with the standard shunt motor. This we take advantage of in starting. The fields are thrown directly across the line, impressing 115 volts on each field.

As soon as the motors have started to turn, the fields are brought to normal, and as the cycle progresses, the fields are weakened for speed control as required.

This is a fact whether variable voltage or constant series parallel voltage is used. In the series parallel operation, the motors are started in series, giving advantage of the high torque and the low speed which is required to right the tub, which is at the top of the furnace, and land it on the track safely before acceleration is allowed to proceed.

Our later installations have gone one step further. The variable voltage is made similar to the constant potential voltage. In other words, the variable voltage is also 250 volts, derived from a motor-generator set.

This does another important thing. It allows running on the emergency source at full speed and full capacity, something that cannot be accomplished otherwise.

The system indicated by Mr. Hamilton drops the speed in half when one generator drops out of the picture unless the voltage of the remaining generator is raised. Normally, in previous installations, we would drop the speed to about two-thirds or three-quarters of normal operating speed, when going from variable voltage to series parallel. There is, in addition to that, on our system, provision for driving by single motor, from either motor, either from the variable voltage source or from the constant potential series-parallel source,

which is about the ultimate in availability of skip hoist power.

There have been one or two installations, and Mr. Angel's reference to the one brought it to my mind, where the hoist was in service prior to the arrival of the motor-generator set. We went into a plant recently and found the motor-generator set shut down, with the maintenance people going over it, cleaning it up, etc. In inquiring as to what had happened, the maintenance man said, "Nothing, that is our weekly procedure. We shut the variable voltage system down every Wednesday for maintenance, and for usage of the series-parallel system, which insures continuity of service on both systems at all times."

That is another feature which we have always stressed in utilizing contactors for reversal as we do, rather than the field reversal system such as is used by the rotating regulator system. The equipment used for reversal is used on both the variable voltage system and on the constant potential system, and it is used continuously, insuring its reliable operation at all times, under either condition.

C. P. Hamilton: Local conditions and preferences often dictate the extent to which all of the provisions for a blast furnace electrical system can be included that have been presented in my paper. However, it is pretty well established that the ultimate aim is to provide a system that will assure continuity of operation of the furnace. Knowing what the essential provisions should be, anything less can then be taken out at a calculated risk. When a new furnace is installed, the cost of the system that has generally been described is a relatively insignificant part of the total furnace cost, and all of the benefits provided can be justified. However, when old installations are to be modernized, usually only a small part of the overall electrical system is involved at a time in the program, though it should be pointed toward the ultimate integration of the entire blast furnace system.

Mr. Angel asked if many installations used a combination of motor-generator set and rheostat control. I do know of several installations of single and two motor hoist that use this alternative control arrangement, though it does not seem to be very common practice to the best of my knowledge. One company has another arrangement of driving a three-unit motor-generator set by using one of the generators as a motor in case the "high line" should fail and operating the skip hoist from a single generator. Mr. Ferguson in his discussion pointed out, a fundamental characteristic of balance skip hoist drives of requiring high motor torque as the loaded skip is started from the pit and until the empty skip starts down the incline. This characteristic is also taken into account in the system described by normally running the motors with greatly weakened shunt field excitation, quite comparable to the system described by Mr. Ferguson, and "field forcing" during the period of starting to obtain maximum torque per ampere. By connecting the armatures of the motors and generators in a series loop system, the problem of motor load division is eliminated and also results in a very simple control setup. However, when the motor armatures are connected in parallel, it is necessary to use a series field winding to obtain a sufficiently drooping motor speed characteristic to assure load division, which requires the use of eight motor armature reversing contactors instead of just one loop circuit contactor, largely included for safety reasons.

In the system described in the paper, the speed of the skip is only reduced to approximately 75 per cent when one motor and generator is taken out of service rather than 50 per cent mentioned in the discussion. The motor torque per ampere is increased by "field forcing" to approximately 140 per cent over normal operation so that the motors, when properly selected and geared, operate only slightly beyond the normal current rating when the skips are carrying normal ore loads.

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GAS TURBINES FOR THE STEEL INDUSTRY

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. . . . paper presented at the American Power Conference sponsored by Illinois Institute of Technology, Chicago, Illinois, March 24-26, 1954 . . . .

▲ IN a steel plant the blast furnace is a large producer of a usable fuel of low calorific intensity. Approximately 100,000 to 150,000 cubic feet of gas, with a heat content of about 90 Btu's per cubic foot, is produced for every ton of iron produced. Twenty to thirty-five per cent of this gas is used to preheat the air used in blowing the furnaces and in losses, leaving sixty-five to eighty per cent, or about six to nine million Btu's per ton of iron, available for other uses. In fact, the availability of energy in waste gases from steelmaking and heating operations in fully integrated steel plants is one of the principal reasons for the existence of their large power plants.

Early in this century, large installations of gas engines were made in many steel mills for utilization of blast furnace gas for generation of power and to furnish "wind" for blowing of furnaces. Many of these installations exist today. These engines operate at high thermal efficiencies, efficiencies that have been met only by our best steam plants. They have, however, three serious drawbacks—the operating maintenance is high, the manhours required to operate them are large, and they require excessive space for a given output. For these reasons the trend has been to steam plants; the last gas engines were installed about 1930. Steam plants are reliable, operate at lower cost, require less area for a given output, and have a much higher availability.

We now face a new era, that of the gas turbine, with its promise of still lower operating costs, lower area requirements, simplicity of operation, water requirements only a fraction of that of a steam plant, and possibly lower investment cost. It is estimated that man-hours in a given gas turbine plant should be less than one-half of the hours it takes to operate a steam plant with its water treating plant and other auxiliaries. Area requirement shows the same promise. In addition, blast furnace gas should be an excellent fuel for gas turbines because of its low flame temperature and high density of products of combustion. The steel industry has therefore watched with keen interest the development of this new prime mover.

An investigation was made of two steel plant blast furnace gas fired turbines installed in Europe. One is at the Arbed Steel Works, Dudelange, Luxembourg, rated at 5400 kw for plant power. The other provides 29,500 cfm of air at 29 psig to a bessemer converter, and is installed at Baracaldo, Spain.

BLAST FURNACE GAS COMBUSTION TESTS

This interest then reached a material stage when, during the middle of 1952, an agreement was reached between the United States Steel Corp. and an electrical manufacturer for the erection of a combustion test system at the former's Carrie Furnace of the Homestead District Works.

A similar agreement was reached between the Jones & Laughlin Steel Corp. and another manufacturer. Tests were conducted at the Aliquippa plant of the J&L Steel Corp., starting at about the same time as those at the United States Steel Corp. plant. Although the development of the test systems and the obtaining of test results were done independently at these two installations, the results obtained were remarkably similar. This speaks well for the future of the gas turbine in the steel industry.

The purpose of the test program was to explore the possibilities of burning blast furnace gas in an internal combustion gas turbine and to develop suitable equipment for such an application.

Figure 1 shows the line diagram of the test installation at the United States Steel Corp. plant. The flow paths through the various components of the system and the flow metering stations for the fuel gas and air are indicated. The flow rates, pressures, and temperatures which actually exist in gas turbine combustors cannot be readily reproduced with test equipment. It is necessary to carry out combustion tests with conditions which simulate those of actual operation as closely as possible, but with much smaller mass flow rates. Previous test experience with other fuels has shown that operating conditions in gas turbine combustors can be reproduced adequately, if the velocities at the test conditions are the same as actual operating velocities.

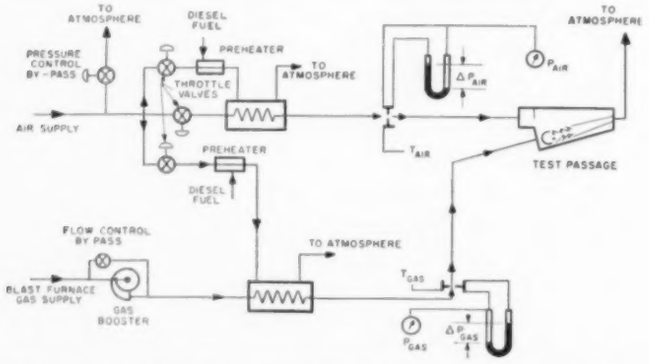

Figure 1 — Line diagram of blast furnace gas combustion test installation.

The combustor used in the test passage was one of the standard type as used in a 5,000-kw gas turbine power plant. The maximum pressure in the combustor during the tests was 15 psia. In order to obtain an air velocity comparable to that of the actual gas turbine plant, the air flow was reduced in the ratio of the density at 15 psia to that of the air compressor discharge pressure from the 5,000-kw gas turbine power plant. Air and gas temperatures throughout the combustion section of the turbine can be exactly reproduced in the test system, hence no modification of test operating conditions for temperature corrections were required.

Initial tests of the combustor design indicated that modifications to the gas admission nozzle were required to improve combustion and flame stability for full and part load operation. A variety of different nozzle designs were tested and the requirements of a satisfactory design were obtained. Once determined, all further tests were conducted using the final nozzle design. With this nozzle, tests were made to determine the effect of variations in inlet air and gas temperatures on efficiency, stability, and ignition.

The tests indicated that blast furnace gas can be ignited and burned with efficiencies comparable to those obtained when fuel oils or gases with higher heating values are used in gas turbine combustors. No detrimental effects from burning blast furnace gas, such as combustor deposits or excessive corrosion, were encountered.

Tests with the various nozzle designs indicated that ignition, stability and efficiency are improved when inlet air and gas temperatures are increased. Stable operation at all load conditions was maintained whenever the inlet air and gas temperatures to the combustors were above 250 F.

A second phase of the tests was the investigation of the corrosion properties of blast furnace gas dust at high temperatures on gas turbine blade materials. Dust samples from Carrie blast furnace gas were mixed with diesel oil and burned in the blade corrosion test passage at research laboratories. The dust concentration in the oil was equivalent to 0.5 grains per standard cubic foot of blast furnace gas. This is approximately double the dust concentration encountered in primary washed blast furnace gas and was used to accelerate the test.

Several blade test specimens were placed in the corrosion test pack and the standard corrosion test, developed for residual oils, was made. The test specimens were lapped to a surface roughness of approximately four microinches before exposure for two hours to the dust contaminated gases at temperatures from 1200 F to 1700 F. The surface roughness of the specimens was measured after exposure to the hot gases; the increase in surface roughness taken as a measure of corrosion. The per cent weight loss due to corrosion was also obtained.

Little corrosion of the specimens occurred. Based on these tests, corrosion due to gas dust should not present a problem. Other data indicate that with present washing and filtering systems there should be no erosion problem when the gas dust content is 0.015 grains per cu ft or less. Compared with the corrosion encountered when a typical high vanadium oil or high sodium oil is used, the corrosion with the blast furnace gas dust mixed with diesel oil was almost negligible. The corrosion with the dust oil mixture was comparable with that found when the best grade of residual oil was tested.

Another phase of the tests was the development of a satisfactory dual fuel nozzle to operate with either blast furnace gas or diesel oil. If all compressed air for a blast furnace plant is obtained from compressors driven by blast furnace gas burning turbines, an auxiliary fuel must be used for start up and emergencies during which blast furnace gas may not be available. It is therefore necessary to equip the gas turbines with an auxiliary fuel system. With this in mind, several tests were conducted in order to develop a satisfactory dual fuel nozzle to burn either blast furnace gas or diesel oil.

The result of all of the combustion tests have shown that blast furnace gas can be successfully burned in high heat release gas turbine combustors with high

efficiency. The flame stability, ignition characteristics, and dual fuel nozzle details are established.

Gas turbine power plants can be made suitable for use with blast furnace gas fuel by modification of the combustors, addition of blast furnace gas compressors, and the necessary adjustment of aerodynamic flow paths. This latter is necessary because of the large volume of inerts in the blast furnace gas and the gas fuel flow becoming approximately twenty per cent of the total flow through the gas turbine.

At the successful conclusion of the blast furnace gas combustion tests, previously outlined, a decision was made to proceed on an engineering design of an air extraction gas turbine with a continuous rating of 125,000 cfm at 35 psig, to burn blast furnace gas fuel.

Figure 2 shows the outline of a complete 125,000-cfm air extraction gas turbine power plant for blast furnace blowing. Atmospheric air is taken in by a 17-stage, axial-flow, air compressor and compressed to 35 psig. This compressor supplies air for both the turbine and

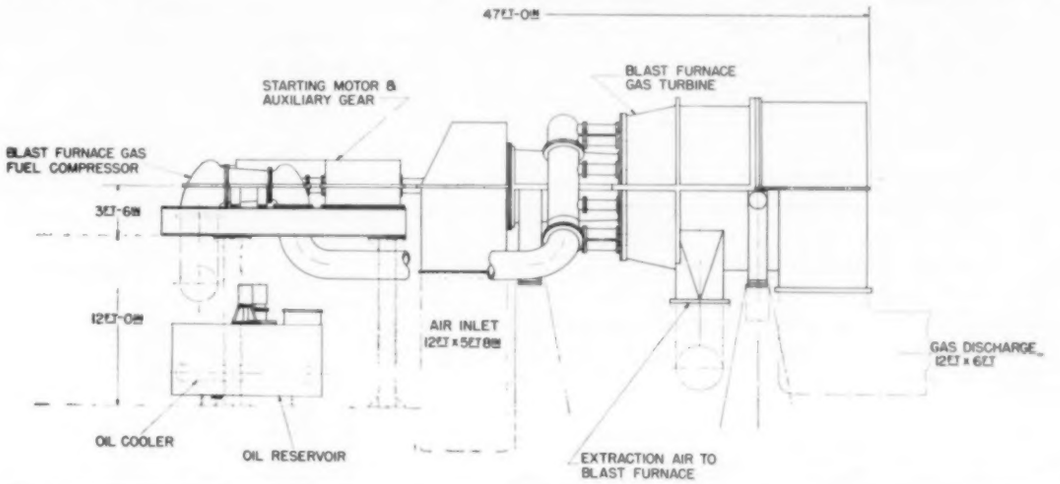

Figure 2 — Outline shows space needed for 125,000 cfm, 35-psig, air extraction, gas turbine power plant.

GAS TURBINES FOR POWER GENERATION

The electric power requirements of steel plants vary widely, depending on final product and degree of reduction and finishing as well as the extent of integration, but generally somewhere between 160 and 300 kwhr of electricity is required for each ton of iron produced.

Large integrated plants and plants grouped into districts are usually served by large steam turbo-generator units 30,000 to 60,000 kw in size. At this time it is not possible to plan on use of gas turbines in units of this size.

Smaller isolated plants on the other hand have use for 5,000 to 15,000-kw installations which may be competently served by the gas turbine.

GAS TURBINE FOR BLAST FURNACE BLOWING

A very attractive application of the gas turbine is that of operating blowers for furnishing air to the blast furnace.

A blast furnace blower blowing a large furnace requires 10,000 to 16,000 hp. Steam generators installed to service steam turbo-blowers generally are of such size as to furnish steam to three or more blowers. The result is that during replacement and expansion programs as blowers are added one by one, there is at times more investment in steam plant than is necessary for the immediate operations. A gas turbine driven blower, on the other hand, is a unit, and therefore can be installed as needed so that capital moneys are invested only as required.

Two electrical equipment manufacturers have each suggested units for this application.

the blast furnace. At the discharge of the axial compressor, an air extraction opening is provided for 125,000 cfm of air, referred to the compressor inlet conditions of 80 F and 14.17 psia, for blast furnace blowing. Blast furnace gas fuel, which has been compressed by its axial flow compressor, is admitted and burned in 10 combustors to increase the gas temperature to approximately 1350 F. The hot gas expands through the three-stage gas turbine which converts the heat energy into mechanical energy to drive the axial blast

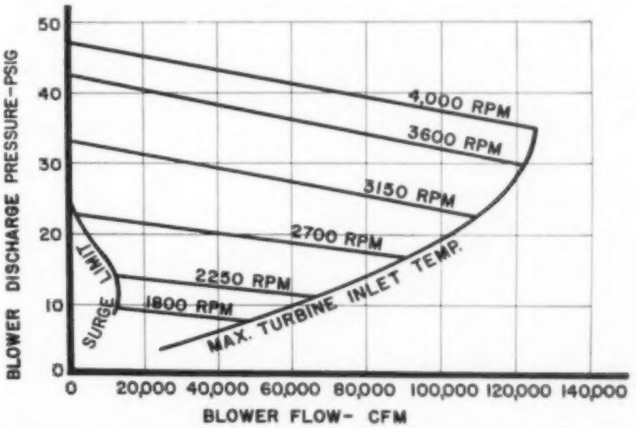

Figure 3 — Operating range curve gives data for 125,000-cfm, air extraction, gas turbine.

furnace gas compressor and axial air compressor. On leaving the gas turbine, the exhaust gases pass through a diffuser and exhaust duct to atmosphere.

Figure 3 shows the air extraction performance of this unit. At the rated extraction flow of 125,000 cfm the turbine operates at 4,000 rpm. Extraction of air flow and pressure are regulated by controlling the speed of the gas turbine. Maximum air discharge pressure is

limited by maximum turbine speed, and maximum extraction air flow is limited by maximum turbine inlet temperature. For any given speed the greater the extraction air flow, the higher the turbine inlet temperature, since an increase in extraction flow means a decrease in air available for combustion of the blast furnace gas in the gas turbine combustors.

The complete plant weighs approximately 75 tons and occupies a floor space of 47 ft by 16 ft with a maximum height of 22 ft.

The phrase, "There's more air than ore in iron" emphasizes that approximately 3½ tons of air is supplied to a blast furnace for each ton of iron produced. While air is "free," it becomes an expensive manufacturing ingredient when thousands of cfm must be compressed to 20-40 psig. Over-all efficiency of the compressing unit is therefore important.

The average modern steam turbo-blower plant has an operating station heat rate of about 22,000,000 Btu's per blast unit. (A blast unit—BU—is equivalent energy in adiabatic compression of air equaling that in 1,000 kwhr.) The best present day steam turbo-blower plant has a station design heat rate of about 17,000,000 Btu/BU.

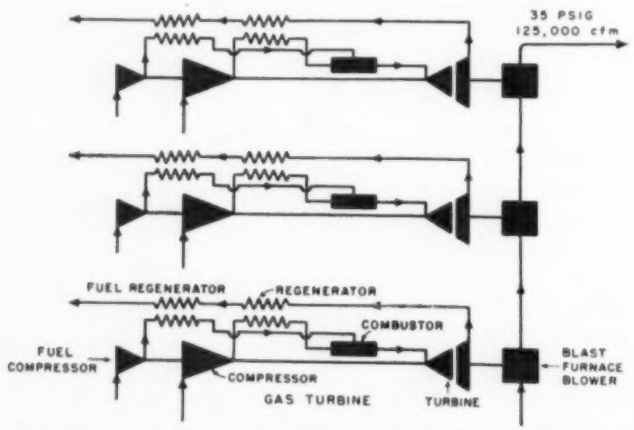

Figure 4 — Three-turbine gas turbine cycle for furnishing 125,000 cfm of air for blast furnace.

The bleed air gas turbine blower unit just described will provide a station heat rate of about 29,000,000 Btu/BU. The addition of a heat exchanger to raise the temperature of the combustion air, by reducing that of the exit gases, will improve the heat rate to about 19,000,000 Btu/BU. Potential development should decrease the heat rate still further.

Of course, as is the case with many steel works and power facilities, it may be desirable to utilize the exhaust gas from a simple cycle gas turbine in a manner contributing more value to works economy than can be gained by a regenerative cycle in the gas turbine.

For example:

1. If the above unit is operated nonregenerative and the full exhaust is passed through a waste-heat boiler, steam will be produced at a rate of up to 100,000 lb per hr at 300 psig, 600 F total temperature.

2. The exhaust could be used for heating feed water to existing steam plants as described in the article, "Gas Turbine on the Line," by J. W. Blake, superintendent of generation, Oklahoma Gas & Electric Co. (Electric Light and Power, May 1953).

Other uses and cycles will undoubtedly be suggested for best overall use of this available energy.

One manufacturer has advanced a cycle for obtaining the necessary amount of air for a blast furnace of large size, utilizing three of their present 6,000-hp gas turbines as a unit, with each turbine driving a centrifugal blower.

These blowers would be operated in series so that the entire flow passes through each blower, and about one-third of the pressure rise is obtained in each unit. Figure 4 indicates the cycle proposed. The blast furnace gas would be compressed in a centrifugal compressor attached to each unit. Fuel gas and combustion air would be regenerated by the exhaust gases of the turbine. An over-all efficiency of 22 per cent would be realized to the shaft of the prime mover. With a centrifugal blower efficiency of 78 per cent, the station heat rate to energy in the blast would be about 20,000,000 Btu's per blast unit.

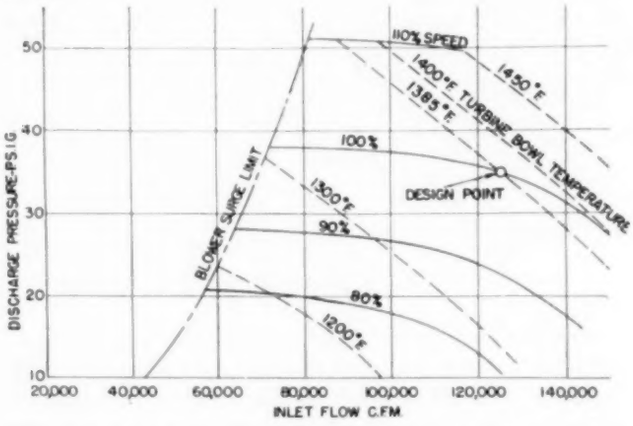

Figure 5 — Performance curve shows capabilities of three-turbine cycle 125,000 cfm plant.

Figure 5 illustrates the performance curve expected from this cycle. Of interest is the ability to take one of the gas turbines out of service for routine maintenance and still supply a major part of the required blast to the furnace.

Space required by these units, complete with regenerators, and interconnecting ducting, would be approximately 3,000 square feet.

SUMMARY

The development of gas turbines has reached the point, in other industries, that gas turbines operate with good records. Therefore, the use of the gas turbine is indicated for the steel industry; particularly since the primary power fuel in most steel plants is blast furnace gas. The development of the gas turbine for burning blast furnace gas, and its control system, has already started. The next step in the application of gas turbines in the American steel industry should be to design, manufacture, install, and operate a gas turbine plant blowing a blast furnace or for generation of power. This planned installation would provide operating data and experience to guide future gas turbine installations for blast furnace blowing, power generation, and other applications in the steel industry and American industry in general.

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THE DIVERSITY OF PRODUCTS OF LOW INDIVIDUAL TONNAGES

. . . . western rolling mills have a difficult problem in furnishing the wide variety of sections needed by western manufacturers and still maintaining economical mill production schedules . . . .

▲ ENGINEERS actively concerned with the great variety of engineering problems involved in the production of steel mill products are acutely aware of the importance of tonnage in the operation of a modern steel mill. Steel has gained its position as the primary industrial material in our American way of life only because it can be delivered to the consumer at a low cost. It is possible to attain this low cost through the use of the most efficient production techniques the individual mill can afford. In order to maintain these costs, it is necessary, of course, to have orders for large quantities of individual items.

In spite of this self-evident requirement, we find it necessary to operate our mills with a far-from-ideal product pattern, where tons per section are of so much importance to our operation. Our schedules cover a great variety of sizes, shapes and grades, and usually include a considerable number of items with only a small tonnage involved. It is this general problem of the wide variety of sizes, shapes and grades involving low individual tonnage requirements that will be reviewed. A general understanding of the circumstances surrounding this situation will help all in dealings with this problem.

While this general problem exists in the production of most steel products, the following comments are confined to those products rolled by merchant bar mills and light structural mills in the far west, in other words, reinforcing bar, merchant bar, and structural shapes, up to approximately 6 in. dimensions.

In order to get a better picture of the problem, let us first briefly analyze the economic conditions and developments that are primarily responsible for creating this situation.

First think of steel mill products as being strictly a raw material. While we often term them "finished products," they are in fact essentially a raw material from the standpoint of most consumers. Also, let us remind ourselves that steel mills are established in order to service a need which has developed. The product which the mill is to produce is determined by and is totally dependent upon the steel requirements within the marketing area of the mill. With those two thoughts in mind, let us now take a quick look at the basic economic factors which have influenced the development of the steel industry in the west.

It was the Gold Rush of '49 that provided the first major impetus to the industrial growth of the pioneer west. This phenomenon resulted in a great surge in population, and immediately created furious activity in the building of railroads, buildings, bridges, docks, ships, etc. While the San Francisco area was the hub of this activity, the resulting increase in commerce was an important factor in the development of the entire west.

It is interesting to note that in 1848, California had some 14,000 people. By 1852, the population reached 255,000 and by 1860, the state was the home of approximately 380,000 persons.

In those hectic early days every piece if iron used in the mines, in building railroads and for other construction had to come by sailing vessel around the Horn. Because of the time and expense involved in such a voyage, there developed a crying need for a local source of common steel commodities to be used for the

building of the west. It was in 1868 that the first iron was produced in California by the Pacific Rolling Mills Co., at San Francisco. This plant melted railroad scrap with the aid of coal from Australia and rolled the iron into bars.

From such modest beginnings, the seven western states have taken tremendous strides in the past century in the development of the steel consuming and steel producing industries. Not only has the size of the market increased, but, more pertinent to our point today, we find that the requirements of our market are growing more and more complex in nature.

Whereas, formerly, the product of western bar mills was taken almost entirely by the construction industry, we now furnish important tonnages to the rapidly growing manufacturing industries. It is in this manufacturing group that we find the bulk of the need for a wide range of sizes and grades, particularly in the bar classifications. Also, it is in the manufacturing class of trade that we expect to find the greatest development in the next decade.

Two primary factors in our western economy are providing the force behind this rapid development of the manufacturing industries in our area. The first is the tremendous increase in costs which is facing the eastern manufacturer who distributes his products to the western markets. Freight charges have increased almost threefold in the past fifteen years. Inventory and distributing costs in maintaining such a long supply line have grown in proportion.

Coupled with this situation is the tremendous growth in population registered in the west. Since 1940, the seven western states have added six million people, an increase of over 50 per cent of the 1940 population.

These factors are causing the western states to develop an economy more and more approaching a state of self-sufficiency with regard to manufactured products. We have a long way to go in this respect, and considerable time will be required; however, our manufacturing industries will grow steadily toward this end.

The point in outlining briefly the market situation contributing to the development of manufacturing industries lies in the belief that this category of trade, which accounts for the bulk of our low tonnage requirements, is in for a series of new developments. As new products are manufactured here, steel producers will be called upon to supply new sections, sizes and grades to meet the varied requirements.

Western manufacturing industries, during their development, will take on a wide range of products. Because the products made in the west will be consumed primarily in the west, it must be expected that the size of the market available to our manufacturers will force them to operate on a smaller scale than their eastern counterparts, at least temporarily.

Another primary factor contributing to this problem in the west is the unusually large number of small manufacturers in our market. Consider for a moment that of the 7,900 metal working plants in the seven western states in 1951, only 2,300 employed twenty or more people, and 5,600, or 70 per cent employed less than twenty people. The importance of the steel jobber to the growth and development of these smaller manufacturers is self-evident. In turn, the jobbers perform a vital function in accumulating the myriad requirements of these manufacturers to a considerable degree.

Even with the jobbers' aid, we still are confronted with a tremendous variety of sizes and grades, many of which present minimum tonnage problems.

All of this boils down to a problem of growing pains. The feasibility of manufacturing any particular product on the coast is determined first by the market available for the finished item, and second by the availability of materials and costs of manufacturing. While western manufacturing is in this growing stage, local steel mills will continually be confronted with the problem of servicing manufacturers who require relatively small quantities of a particular size or specification.

The problem in this regard is compounded by the geographical location of the three major market areas in the west. The freight rates between southern California, northern California, and the Northwest have become so substantial that shipment of steel mill products from one of these areas to either of the others is not fundamentally sound if similar products are produced in the area to which the product is shipped. This freight factor alone contributes heavily to the problem of small tonnage requirements for the unusual sizes and grades, since each plant must tailor its range of sizes to the requirements of only the surrounding market area. The western market is split three ways; such division greatly diminishes the tonnage per size available to a mill located in any particular market area.

Now let us take a look at this problem of low tonnage requirements as it exists today in the products under discussion, namely, reinforcing bars, carbon bars, and structural shapes.

With regard to reinforcing bars, we find relatively few problems. Only a few sizes are produced and only two specifications are required. Furthermore, the western states present a good volume consumption on this product, as they account for some twenty-five per cent of the total reinforcing steel used in the United States.

The situation with regard to standard structurals is not too critical. The size ranges and specifications are rather simple and well-defined. However, because of the restricted nature of our three major markets, we quite often are confronted with the request to roll some of the less popular weights of a section and many times have difficulty in putting together a respectable rolling tonnage.

As mentioned before, our principal difficulty with low individual tonnage requirements lies in the bar range.

With this brief resume of the character of the market we serve, let us take a look at the mill equipment we have in the west, for it is with this equipment that we must cope with a bar market of wide variety and low individual tonnage requirements.

Within the states of Washington, Oregon and California, there are eighteen rolling mills engaged in producing the type of products in which we are interested at the moment.

The state of Washington has three of these mills. In the city of Seattle are located a 10-in. mill, 12-in. mill and a 22-in. mill. Portland, Ore., has one mill, nominally a 14-in. mill, with two additional housings taking 9-in. rolls. This latter feature, of course, allows that mill to roll a wider variety of sections than would be pos-

sible without these additional stands. The same is true with the 12-in. mill in Seattle, which has two 8-in. housings which permit this mill to broaden its product. The value of these two small housings at times is questionable.

California is the home of the remaining fourteen mills. In this state are located one 9-in. mill, one 10-in. mill, six 12-in. mills, one 14-in. mill, one 18-in. mill, one 22-in. mill, one 26-in. mill, and two 10-in. rod mills, one of which is a combination bar and rod mill. Six of these mills are located in the Bay Area, eight in the Los Angeles area.

To be sure, there is no shortage of mill capacity for the sections produced by this variety of rolling mills. In fact, a study of the average tons per hour for these mills indicates what could be done if they were called upon for an all-out performance. The figures vary from as low as five tons per hour to the high of forty-seven tons. Should the average, 21.3 tons per hour, for all these mills be projected toward an all-out effort, maximum production, they are capable of producing over three million tons annually, in fact, nearly three and one quarter million tons. These mills came the nearest to that staggering figure in 1953, when they produced approximately 1,710,000 tons. We have no shortage of rolling capacity for the general line of sections which mills of this type are called upon to roll. This is easily determined by reviewing the operations of these mills over the last several years. Only a very few of them ever operated on a full twenty-turn per week basis.

There were many reasons for less than all-out production. Sufficient tonnage of small billets for small mills could not be provided and still keep the larger mills going at the best possible rate. This was true in reverse also. When orders indicated a need for the best effort on small mills, they were provided with steel, at times at the expense of the larger mills. No truly happy medium could be met. There were many cases where ingots could not be provided in sufficient quantity to fill the mills. Some of the plants involved in this discussion have other consuming units toward which tonnage was directed at the expense of mills herein referred to. Many problems enter into this story of below-capacity operation. Many changes would be required to alter or improve the situation. They are being made, however, slowly, and while maximum operation may never be reached, still and all, the industry is aiming for it.

My first introduction to the rolling mill game happened at a plant where there were located bar mills of a variety of sizes and types. This variety all being within the one plant meant, of course, that each mill had its own particular chore to do. Rounds, squares, flats, angles and one or two oddities were the usual thing. Size variations were well-defined, and breaking points on all sections were such that the whole range was rolled without any one mill's being particularly hurt by having to extend itself into either extreme. From that standpoint, it was an ideal situation. The situation is much different in our western merchant-bar and light-structural mills, as was pointed out earlier. As added emphasis, though, the eighteen mills which form the basis for this paper are owned by eight different companies.

To furnish our type of product to the consuming trade in the territory, our western mills must of necessity be about as flexible as possible. They must carry billet inventories consisting of a wide range of sizes; and in several billet yards, not only will you find the wide range of sizes, but also an ever growing number of grades. The subject of grades is one which tends to complicate the problem of lots of sizes and too little tonnage per size. The subject of grades is a matter unto itself, and will not be discussed further.

Establish your finish size and shape and then, knowing your mill, provide the proper billet size and weight to make the desired section. That is all that you need do. Broaden your range of finish sizes, and you broaden your range of billets. That is what many of these mills have done. Billets 4 x 4-in. or 2½ x 2½-in. are common. But when one mentions 5¼ x 4⅝ in., 4½ x 2⅝ in., $1\frac{23}{32}$ x $1\frac{7}{32}$-in., and the list is long, one gets some idea of the variety of billet sizes which these mills have adopted. For some of the larger mills, 3½ x 10 in., 8 x 23 in., 12⅝ x 4¾ in., 8¼ x 6¾ in. and many other odd sizes are not at all uncommon. Not the least worry in this billet business is billet weight. All of the mills which have been checked by the writer are operated by people who are very mindful of yield. To verify this, one need only understand the reasons for the billet sizes, some of which were listed before, and note the variation in billet lengths, 5 ft 4½ in. to 30 ft 6 in., with many, many intermediate lengths, and all for a purpose, yield. To be sure, billet furnace dimensions influence maximum lengths; distances between housings influence both maximum and minimum length, but between the two extremes, yield is the controlling factor.

There is no piece of manufacturing equipment which makes any money while it is idle. Downtime on a rolling mill is very costly. Therefore, it is the mill operator's responsibility to be certain that all of those familiar causes of downtime which come under his direct control must be kept at a minimum. His next responsibility becomes one of reducing those causes not directly under his control to their minimum, and in this instance we speak of roll change frequency. We assume he has already reduced, to at least par, the time taken for the necessary roll changes. The operator, with the aid of the roll-pass designer, can work wonders by watching for opportunities to consolidate or combine various roll and pass layouts for sections somewhat similar.

We have attempted to emphasize the flexibility requirements in the mills which we are discussing. The problems which we, as individual mill operators here in the far west, encounter are common to all of us. Not the least of these problems is the wide range of product we require of our mills and the relatively low tonnage provided to us per range.

There is a twelve-inch mill here on the coast which rolls rounds from ⅜ to 2½ in. in diameter, flats from ⅞ x ⅛ in. to 5 x 1½ in., squares from ⅜ to 2¼ in., the usual reinforcing sections, angles from ¾ x ¾ x ⅛ in. to 3½ x 2½ x ½ in. and channel sizes up to 4 in. x 7.25 lb. This is quite a load for any 12-in. mill. With a variety of this magnitude, a forty-five to sixty-day cycle is understandable, in spite of relatively low tonnage per item, and some products are not repeated in each cycle. It is not uncommon to find 350 individual sections in a

rolling cycle. This particular 12-in. mill is mentioned for it is outstanding in the variety of sections rolled. The fact that it has an 8-in. finisher in addition to the 12-in. finisher may add to the total products, but not to the total production if measured in tons, and what is more important? In this connection, when you have a small mill connected to a large mill, as is the case in point, it is usually true that total production and return suffer for it. The usual run of bar mill product requires that the mill produce its range, and if this range is too broad, particularly on the low side, it is quite detrimental to the total operation of that mill.

Actually, as we discuss low individual tonnages and apply the discussion to our western bar mills, we learn that with few exceptions the entire bar product is subject to this low individual tonnage. A twelve-inch mill in the Los Angeles area is subject to be called upon to roll over 450 different sections during one rolling cycle. This mill is the exception and not the rule. Other mills, similar in size, are subject to the more or less standard mill sizes, and even they must be prepared to make over 300 different sections. True, the bulk of these sections is composed of flats, but in mentioning 165 sections in the flat range per rolling cycle, we are speaking in increments of ¼ in. in width and ⅛ in. in thickness. Twice that total would be more nearly correct when one studies the mill schedule.

We have established other averages covering these particular mills within this area. One of the more significant figures is that which gives a picture of the average tons per section per range rolled. Reinforcing bars average 425 tons per section rolled. This is the highest tonnage per range rolled of the several sections. Channels, averaging 152 tons per section, are second high, and they are followed by I-beams 142, rounds 130, squares 120, angles 115 and lastly, flats at 81 tons per section rolled. It is not uncommon for flat rollings to carry the greatest tonnage of any range during a rolling cycle; and to cover the multitude of sections encountered in a flat rolling in the minimum of time certainly requires the best of scheduling practices.

Roll changes are not too frequent on flat rollings, but pass changes and other mill adjustments must be made with each fractional change in section. To confirm the first part of this last statement, we find that roll changes on flats occur approximately every 310 tons rolled. Only one other section requires fewer roll changes, and that, of course, is reinforcing. Reinforcing rolls, for one reason or another, require changing on the average with every 390 tons rolled, angle rolls with every 258 tons, rounds 236, channels 233, squares 210 and beams with every 98 tons rolled.

The frequency of these changes does not depend entirely on tonnages scheduled. Other factors enter into this matter, and we refer particularly to pass life and those difficulties which are peculiar to mills, such as mill wrecks, collared rolls and, of course, mill product inspection.

Several mills have been left out of this discussion purposely. We are not concerned at the moment with hot and cold mills, tin plate mills or modern up-to-date structural mills. We have confined our remarks to mills similar in type, though somewhat different in actual layout. We have considered the 9 and 10-in. mills, the 12 and 14-in. mills and several which range in size between 18 and 26-in. Most of these mills are required to roll a broad range. The reason has been given. It is understandable that, with so many similar mills in the area described, there would exist the problem of low tonnage items.

Early in this discussion an attempt was made to bring out a few of the primary reasons why the market we serve requires an unusually large proportion of bar sizes and grades in the low individual tonnage category.

Because of the anticipated growth in scope and variety of the manufacturing industries, we can expect to be confronted with a great many more products in this classification. Indeed, because of the geographical make-up of our three major market areas on the coast, which encourages a great variety of manufacturing enterprises on a relatively small scale, it is our belief that the western bar mills will be confronted with this problem for some time to come.

This situation places emphasis on mills capable of extreme flexibility in the bar range. This paper has outlined in brief fashion the bar mill facilities we have on the coast and have attempted to indicate how these mills are taxed from the standpoint of low tonnage per individual item.

In closing, one must remember, the important role the bar mills will be called upon to play in aiding the manufacturing industries through the growing pains that are inevitable in their development. A number of the mill products which start out as a minimum requirement will certainly grow into sizeable and desirable mill sections, as the manufacturers are able to expand and develop their activities.

The steel industry has a responsibility to encourage the further development of those manufacturers in our areas who show promise of healthy growth. By working closely with these manufacturers, all can contribute real assistance in the further development of our western industrial economy. This assistance will also aid materially the very subject we have been discussing.

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Program

AISE
SPRING CONFERENCE

AUSPICES OF
ROLLING MILL COMMITTEE

BELLEVUE - STRATFORD HOTEL

PHILADELPHIA, PA.

MAY 3, 4, 5, 1954

Monday, May 3, 1954

9:00 am — Registration — 18th Floor

9:30 am — COMBUSTION SESSION — South Garden

Chairmen: George J. Gockstetter, District Combustion Engineer, Republic Steel Corp., Chicago, Ill.

F. R. Pullen, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

"The Fairless Soaking Pits," by Charles R. Wilt, Jr., Combustion Engineer, Loftus Engineering Corp., Pittsburgh, Pa.

"Maintenance of Slag-Bottom Soaking Pits," by John A. Warchol, Supervisor, General Labor, Lukens Steel Co., Coatesville, Pa.

9:30 am — ROLLING MILL SESSION — Rose Garden

Chairmen: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. C. Schaefer, Superintendent Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio.

"Increased Rod Production by Conversion of a Two-Strand Rod Mill to Three-Strand Operation," by C. H. Burden, Chief Project Engineer, and W. E. Zelley, Divisional Plant Engineer, John A. Roebling's Sons Corp., Trenton, N. J.

"Modernization of Rod Mill at Steel Co. of Canada," by D. W. McLean, Assistant Superintendent of Rod and Bar Mill, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

2:00 pm — MECHANICAL AND LUBRICATION SESSION — South Garden

Chairmen: C. R. Hand, Assistant Superintendent, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

E. C. Hite, Assistant Superintendent of Maintenance, Steel and Tube Div., Timken Roller Bearing Co., Canton, Ohio.

"Screwdown Lubrication," by William A. Holt, Eastern District Engineer, Brooks Oil Co., Philadelphia, Pa.

"The Application of Lubricants to Rolling Mills — Problems, Developments and Trends," by Wayne G. Ritter, Trabon Engineering Corp., Pittsburgh, Pa.

"Water Processing at Fairless Works," by H. S. Spitz, Chief Engineer United States Steel Corp., Fairless Hills, Pa.

2:00 pm — ROLLING MILL SESSION — Rose Garden

Chairmen: A. Krause, Manager—Rolling Mill, Steel Div., Ford Motor Co., Dearborn, Mich.

Alex Montgomery, Jr., Assistant to Vice President — Rolling, United States Steel Corp., Pittsburgh, Pa.

"Rolling of Shapes in Alloy and Tool Steel Grades," by Ernest E. Davis, Superintendent Hot Mills, and Albert H. Highley, Assistant Superintendent Hot Mills and Roll Designer, The Carpenter Steel Co., Reading, Pa.

"Roll Knurling at South Works, United States Steel Corp.," by E. M. Benedict, Superintendent, Roll Shop, South Works, United States Steel Corp., Chicago, Ill.

"Modern Manufacture and Use of Cast Rolling Mill Rolls," by Dr. F. H. Allison, Jr., Vice President and C. E. Peterson, Sales and Research Metallurgist, Rolls Division, Blaw-Knox Co., Pittsburgh, Pa.

Tuesday, May 4, 1954

9:00 am — ELECTRICAL SESSION — South Garden

Chairmen: K. L. Johannsen, Division Superintendent, Maintenance and Utilities, United States Steel Corp., Fairless Hills, Pa.

R. T. Lucas, Electrical Superintendent, Weirton Steel Co., Weirton W. Va.

"Operating Characteristics of Tandem Mill Drives," by R. G. Beadle, Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Electrical Power Distribution and Utilization at Lone Star Steel Co.," by R. G. Orthwein, Chief Electrical Engineer, A. J. Boynton and Co., Chicago, Ill.

"Unique Electrical Features of the Fairless Universal Slabbing Mill and Hot Strip Mill Finishing Train," by Warren Reid, Steel Mill Engineer, and R. H. Wright, Steel Mill Engineer, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

9:00 am — ROLLING MILL SESSION — Rose Garden

Chairmen: C. S. Lambert, Superintendent Merchant Mills, Campbell Works Youngstown Sheet and Tube Co., Youngstown, Ohio.

C. E. Pritchard, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

"Performance Factors Affecting Bar Mill Cooling Bed Arrangement," by E. C. Peterson, Engineer, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

"Plate Mill Design and Rolling Practice," by Elmer Lynch, Superintendent Plate Mills and Tank Head Dept., Sheffield Steel Corp., Houston, Texas.

"Cold Reduction Facilities at Fairless Works," by Robert R. Shedd, Design Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

2:00 pm — FAIRLESS SESSION — Rose Garden

Chairmen: J. N. Imel, Superintendent Sheet and Strip Dept., Jones and Laughlin Steel Corp., Pittsburgh, Pa.

Leonard Larson, Chief Engineer, Republic Steel Corp., Cleveland, Ohio.

"Iron From Cerro Bolivar," Talk and Movie by John L. Young, Vice President — Engineering, United States Steel Corp., Pittsburgh, Pa.

"Engineering Conception of Fairless Works," by J. D. Rollins, Assistant Vice President — Engineering, United States Steel Corp., Pittsburgh, Pa.

"Modern Continuous Weld Pipe Mill," by L. V. Johnson, Chief Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

7:00 pm — INFORMAL STAG DINNER — Ball Room

Speaker: M. W. Reed, Executive Vice President — Engineering and Raw Materials, United States Steel Corp., Pittsburgh, Pa.

Wednesday, May 5, 1954

8:30 am — INSPECTION TRIP —

Fairless Works of United States Steel Corp., Fairless Hills, Pa. Buses leave from Bellevue-Stratford Hotel.

HOTEL RESERVATIONS

For hotel reservations, write directly to the Bellevue-Stratford Hotel, Philadelphia 2, Pa., giving time of arrival, type of accommodations desired, and period of stay. Reservations should also state that they are for the 1954 AISE Spring Conference.

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Abstracts of Technical Papers

TO BE PRESENTED AT TECHNICAL SESSIONS OF

AISE ANNUAL SPRING CONFERENCE

PHILADELPHIA, PA.

MAY 3, 4, 5, 1954

"THE FAIRLESS SOAKING PITS"

by Charles R. Wilt, Jr., Combustion Engineer, Loftus Engineering Corp., Pittsburgh, Pa.

C. R. WILT, JR.

▲ THE work at the Fairless works involved the design and erection of twenty soaking pit furnaces, covers and other related equipment. The furnaces are of the two-way, top-fired, recuperative type and are arranged, in line with the 45-in. slab mill, in ten batteries of two furnaces each. On centerlines, the furnaces are 14 ft 6 in. wide, 20 ft long and 14 ft deep to the breeze line. All walls have a 6-in. camber and are faced with quarried silica stone.

The waste gases leave the furnaces through two ports in the bottom of either end wall and are drafted through the recuperator tubes. The air enters the bottom of the recuperator, makes three horizontal passes around the tubes, and then rises through the uptake to the burner port. The tubes are fireclay, with the exception of those at the combustion air entree, which are silicon carbide. Leaving the recuperator, the waste gases are drafted through brick-lined flues to a 115-ft stack shared by both furnaces of the battery.

All controls are hydraulic, with the exception of the furnace temperature control and the fuel safety shut-off which are electric and pneumatic respectively. Each furnace is equipped with fuel-air ratio, furnace pressure and air and gas balancing regulators, the latter of which insures equal division of the air and gas flows to both ends of the furnace. In addition to the above controls, each panel mounts meters recording furnace pressure, furnace temperature, recuperator temperatures, air and gas flows.

Two departures have been made from conventional soaking pit controls. Instrumentation has been provided for the control of recirculated waste gases through the combustion air system, and a second control index and timing circuit has been added to the temperature controller. The functions of these two controls are called "flame tempering" and "heat acceleration" respectively.

Auxiliary equipment has been furnished for the handling of coke breeze and bottom cinder. Sand storage, tong cooling, sanitary, locker and office facilities have been provided to complete the installation.

"MAINTENANCE OF SLAG-BOTTOM SOAKING PITS"

by John A. Warchol, Supervisor, General Labor, Lukens Steel Co., Coatesville, Pa.

▲ THE production rate of a steel plate rolling mill is related to the speed with which the heating units can supply properly heated steel ingots. Unless the capacity of the heating units is much greater than the capacity of the rolling mill, heating delays will result with a resultant decrease in production at the mill. A factor which reduces the heating capacity is the time required to remove the slag which accumulates in the bottom of the pit during heating operations.

In the operation of a slag bottom soaking pit, all the slag remains in the pit as opposed to a coke bottom pit—when the slag is flushed through the bottom. Thus, period between slag removals should be shorter in the case of a slag bottom pit.

The procedure for removing the slag from a slag bottom soaking pit is as follows:

Immediately after a pit is down for slag removal, water is used to cool the slag and simultaneously crack the slag making it easier to cut with a paving breaker. This watering operation continued for 24 to 32 hours depending on the heat conditions. When the pit is cool enough to start working, a crew of six men is employed to break up the slag using paving breakers. This slag is then removed using a magnet. The use of the magnet

replaced the manual method of shoveling and is very effective where the slag is free of non-metallics.

The slag cutting operation and removal with a magnet is alternated until all slag is removed, consuming between 16 and 24 hours. To minimize the time for removing the slag, the removal should be done when crane service is at peak availability. Pits which are down for slag removal when the mill is not rolling have been cleaned out in 8 hours.

Several factors which affect the speed with which a pit becomes full are discussed. These factors are heating practice and scheduling of ingots of various sizes which affect a systematic procedure of drawing pits without a lengthy heating time.

"INCREASED ROD PRODUCTION BY CONVERSION OF A TWO-STRAND ROD MILL TO THREE-STRAND OPERATION"

by C. H. Burden, Chief Project Engineer, and W. E. Zelley, Divisional Plant Engineer, John A. Roebling's Sons Corp., Trenton, N. J.

C. H. BURDEN

▲ DURING March 1929, the John A. Roebling's Sons Co. started rolling rods in a new rod mill which was designed to roll 20 tons per hour of rod from 2 × 2-in. billets. The mill consisted of 20 stands with parallel finishing mills of six stands each. The smaller rods finished at approximately 4000 fpm and coils were reeled on one or the other of two pouring reels provided for each finishing mill.

This mill performed in a very satisfactory manner for several years, but the increased production required by the war effort and in the years immediately following the cessation of hostilities made an increase in rod rolling capacity an absolute necessity.

W. E. ZELLEY

The installation of an additional mill was found to be impractical, so efforts of the John A. Roebling's Sons Co. engineering department and of the mill manufacturer's engineers were directed to increasing present mill capacity.

The obvious means to accomplish this end was to convert the 2-strand mill to 3-strand operation, but several factors were present that complicated this proposal. One of these was the fact that the mill was a parallel finishing mill rolling only one rod at a time in each mill. Although other mills had been altered to roll additional rods, most of them were able to do it by adding the additional pass in the line throughout the mill. Motor size was also a subject of considerable comment as well as the effect of added load on the mill drive gearing. Another important factor was the reeling method to be used and where additional reels, if used, could be located and how they could be driven.

The authors describe the general plan of the mill change, and the method used in solving the troublesome problems presented. In addition to that, they describe the steps taken to make the change with a minimum of production loss, and describe many of the outstanding details which were necessary to make the conversion successful.

"MODERNIZATION OF ROD MILL AT STEEL CO. OF CANADA"

by D. W. McLean, Assistant Superintendent of Rod and Bar Mill, The Steel Co. of Canada, Ltd., Hamilton, Ontario Canada

D. W. McLEAN

▲ THIS paper deals with the conversion of a two-strand, 16-stand rod mill, built in 1913, to a more modern design, 3-strand, 20-stand mill.

Bevel gear drives, belt pulleys and side dump reels have been replaced with enclosed design drives, laying reels and additional drive motors added.

The mill is the sole supplier for several wire mills and the conversion was accomplished without shutting these down, in a five-week period.

The paper describes in general how this was accomplished and some of the problems encountered after the start-up, the author describing a few of the changes made from the original design.

"THE APPLICATION OF LUBRICANTS TO ROLLING MILLS — PROBLEMS, DEVELOPMENTS AND TRENDS"

by Wayne G. Ritter, Trabon Engineering Corp., Pittsburgh, Pa.

WAYNE G. RITTER

▲ MORE than a decade of record breaking steel production, at well over rated capacity of rolling mills, has resulted in an accelerrated rate of deterioration of those facilities. The realization of this on the part of management has resulted in a rapid growth of interest in the techniques of application of lubricants.

Consequently, there is a widespread use of automatic application equipment both in new and existing mills with attendant problems such as training of maintenance personnel, pumpability of lubricants, design of piping systems, and others. These problems are discussed and solutions suggested.

A new development in the continuous spraying of heavy grease on roll necks is described and results stated.

The trend in lubricant application is more and more

toward automation. Its advantage over manual means is discussed.

Types of application equipment are resolved into only two general types with slight variation in specific systems. What some may have heretofore regarded as complex gadgets are shown to be simple basic mechanisms.

"WATER PROCESSING AT FAIRLESS WORKS"

by H. S. Spitz, Chief Engineer, United States Steel Corp., Fairless Hills, Pa.

H. S. SPITZ

▲ THE water processing facilities at Fairless works, including treatment of general service water special process water and potable water, industrial waste treatment of acid, oil and alkali-bearing water produced in conjunction with the steel making processes, clarification of flue dust-bearing water and sanitary sewage treatment, represent the result of intensive investigation of past practices and recent deveopments in the field of industrial water supply.Fairless works requires a water supply of approximately 230,000,000 gallons per day for all services and the treatment of 80,000,000 gallons per day of sewage and industrial wastes.

A central area on the river bank at the south end of the plant was allocated for water, sewage, waste treatment and pumping installations.

Service water is taken from five bays at the pump station face, across river bank sills, through bar racks and traveling screens, then directed either to low lift or service water pump wells. Low lift pumps discharge to settling basins from which about half flows to the power house for condenser and miscellaneous cooling purposes. The remaining half flows to service water wells where it is pumped at 60 psi to the major plant areas. Continuity of service is provided by means of bypassing either set of pumps or the sedimentation basins, and by steam turbine driven pumps at the power house which can discharge into the service water system.

The sheet and tin mill area requires water of better quality than general service water. This clear water is supplied through an isolated distribution network from deep well collectors. Potable water is supplied from a separate collector well through a third distinctly separate distributing system. Boiler make-up water, drawn from the service water supply, undergoes further treatment in a water treatment plant adjacent to the power house.

Due to the variety of wastes produced in the sheet and tin mill and the increased complexity of their disposal problem, a separate treatment plant is located in that area to treat these wastes before combining them with the larger flows from the remainder of the plant. Acids, alkalies, and soluble and insoluble oils are treated by mechanical and chemical clarification, flocculation, skimming and gravity settling with the process arranged to use part of the wastes to advantage in treating other wastes. Sludge from this plant is pumped to a sludge lagoon for storage. The clarified wastes, along with untreated wastes from the hot mill scale pits and miscellaneous wastes from the open hearth area, are pumped to a primary sedimentation basin where the influent is aerated and the oil skimmed for further treatment in an oil and scum thickener. The basin effluent is gravity fed to a secondary sedimentation basin for further settling and oil skimming. The final effluent may be retained in a storage lagoon, recirculated as service water or discharged to the river.

Flue dust produced by the blast furnaces is treated in a separate clarification system located at the furnaces. This equipment consists of a primary thickener, flash mixer, flocculator and secondary thickener. The secondary clarifier effluent is discharged to the river and the sludge is pumped to a separate lagoon for storage.

Sanitary sewage is treated in a separate system consisting of a primary settling and digesting tank, dosing tanks, trickling filters and a secondary settling tank. The effluent is chlorinated before being discharged to the river. Four glass-house sludge drying beds provide for sludge removal.

The water processing facilities are arranged for a maximum of flexibility, allowing for the continuity of operation so necessary in steel making operations.

"ROLLING OF SHAPES IN ALLOY AND TOOL STEEL GRADES"

by Ernest E. Davis, Superintendent Hot Mills, and Albert H. Highley, Assistant Superintendent, Hot Mills and Roll Designer, The Carpenter Steel Co., Reading, Pa.

ERNEST E. DAVIS

▲ BECAUSE of the need for economy in manufacturing parts from alloy and tool steel bars, the rolling of shapes in these grades is becoming an important business. The authors, in this paper, show some of the aspects of this type of rolling. A step by step procedure showing the method used to develop a new section from the initial proposed print to the final bar from the hot mill is given. Some of the problems encountered such as tolerances, surface conditions and shrinkage are discussed. The differences in various alloys and how they roll is also noted in the paper. Because of the way some alloys must be treated when being rolled, certain practices of roll pass design must be used and others avoided. The importance of guides and guide fix-ups is dwelled upon. For various types of steels, different guide materials are used. Some steels adhere to guide surfaces, so plain cast iron guides are used. On other types of steels, hard-faced guides and even roller guides are used to advantage. Illustrations show some methods of overcoming some tough

A. H. HIGHLEY

guide problems. A series of figures showing some typical sections that are rolled in alloy and tool steel grades are also included in the paper.

"ROLL KNURLING AT SOUTH WORKS, UNITED STATES STEEL CORP."

by E. M. Benedict, Superintendent, Roll Shop, South Works United States Steel Corp., Chicago, Ill.

E. M. BENEDICT

▲ THE paper on roll knurling first states the reasons for the consideration and development of various knurling patterns in an experimental program. The results obtained from the current pattern in the form of improved slab surface quality and lengthened roll life are described. Extended application of knurling patterns to other rolling units and the results obtained are presented. A description is also given of the methods that are used in the roll shop to impress the knurl patterns into the roll surface.

"MODERN MANUFACTURE AND USE OF CAST ROLLING MILL ROLLS"

by Dr. F. H. Allison, Jr., Vice President, and C. E. Peterson, Sales and Research Metallurgist, Rolls Division, Blaw-Knox Co., Pittsburgh, Pa.

DR. F. H. ALLISON, JR.

▲ THE standard methods of producing iron and steel cast rolls, with emphasis on the latest improvements in casting, heat treatment, machining and inspection are outlined in the first section. The two general types of roll molds are discussed, as well as the method of making the composite or double poured rolls. The reason for using the drag neck for driving wherever possible is explained. Melting procedures are outlined, feeding the mold head with the aid of the electric arc is illustrated, and the necessity for the return of scrap iron rolls is mentioned. Newer complex methods of steel roll heat treatment requiring narrower limits of temperature are discussed. T-T-T curves are mentioned, and an illustration given of this curve for the 4½ per cent nickel iron roll. Heat treatment has been extended to include certain grades of cast iron rolls with marked increase of service life. Cold rolling of neck fillets to increase fatigue life is currently in the testing phase. Innovations in roll machining methods are described. Inspection methods for hardness, internal soundness and microstructure are illustrated.

C. E. PETERSON

The second section concerns the modern application of rolls and defines the grades according to type and use. Differentiation between iron and steel cast rolls is discussed and the important role of carbon content on wear and brittleness is emphasized. Under the heading of rolls for shape products, the composition, hardness and surface machining patterns of blooming mill rolls, as well as the intelligent application of cooling water, are discussed in connection with fire cracking. The composition of rolls for further reduction of shapes, such as structural, merchant and rod mill roughers and finishers are discussed. The relatively newer deep penetration iron rolls, as well as nodular iron, in some of these applications are mentioned. For flat rolling, new high hardness steel backing-up rolls are available for 4-high cold mills and are finding some use in the 4-high hot strip mills. The 2.5 per cent nickel iron work rolls in the 4-high hot strip mill are, in some cases, being advantageously displaced by cast steel rolls and the 4½ per cent nickel composite iron rolls. In the tandem 4-high cold mills, the 4½ per cent nickel composite iron roll is finding a definite place in the early and intermediate stands. Generalization is a necessity when discussing rolling mill roll applications, due not only to the variation in production methods in the different rollmakers' plants, but in greater measure to the dissimilar rolling practices in otherwise identical rolling mills. The paper concludes with the assurance that the rollmaking industry is vigorously looking forward to discovering roll compositions and manufacturing practices which will reduce rolling costs.

"ELECTRICAL POWER DISTRIBUTION AND UTILIZATION AT LONE STAR STEEL CO."

by R. G. Orthwein, Chief Electrical Engineer, A. J. Boynton and Co., Chicago, Ill.

R. G. ORTHWEIN

▲ THE paper describes the electrical power system at the new steel plant of Lone Star Steel Co. Most of the power for the plant is supplied by the company's own steam generating plant. The installed generator capacity is 25,000 kw, consisting of one 10,000-kw and one 5,000-kw unit.

This power is supplemented by purchased power from South Western Gas and Electric Co. through tie lines with their 69-kv system. Primary distribution throughout the new plant is at 13.8 kv in underground duct system. The power is further converted to 2400-volt a-c, 480-volt a-c, and 250-volt d-c.

Most of the power distribution and conversion equipment is located in the main mill motor room. This room is so arranged that it contains the main drive equipment of four mills, as well as all major distribution equipment.

The usual intermediate mill voltage of 6900 volts was eliminated.

All large motors 1750 hp and over are served directly from the primary system at 13.8 kv. Motors of over 100 hp to 1500 hp are served from 2400-volt unit substations. Motors up to 100 hp are served from 480 volt unit substation. These stations are located in close proximity to the load.

All motor starting and control equipment is located in factory-wired control centers, which were conveniently grouped and located. Power for 250-volt d-c constant voltage shop circuits is obtained from mercury arc rectifiers.

The lighting systems are supplied from the 480-volt load centers by means of separate lighting feeders installed in the roof trusses.

The lighting load is broken down into small units supplied by 25-kva, 480/120/208-volt, 3-phase transformers. Each transformer supplies a 24-circuit, circuit breaker type panelboard. All yard lighting and exterior flood lighting is remote controlled from the motor room.

"UNIQUE ELECTRICAL FEATURES OF THE FAIRLESS UNIVERSAL SLABBING MILL AND HOT STRIP MILL FINISHING TRAIN"

by Warren Reid, Steel Mill Engineer, and R. H. Wright, Steel Mill Engineer, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

WARREN REID

▲ THE universal slabbing mill and the hot strip mill finishing train at the United States Steel Corp.'s Fairless works have many unique features.

Each horizontal roll of the slabbing mill is driven by a directly-connected double-armature motor. Another double-armature motor drives the edger rolls. Six generators supply the three double-armature motors in three, individual series sandwich loop circuits, with two generators and two motor armatures in each loop. Series sandwich loop circuits have been used for many years, but the application of three such circuits for a universal slabbing mill is rather unique.

R. H. WRIGHT

The method of adjusting the position of the edger rolls; and the mechanical and electrical arrangement of the ingot cars, also represent a departure from the previous general practices.

The hot strip mill finishing train consists of six stands, individually driven by d-c motors. The motors are supplied by six ignitron rectifiers. The main d-c bus is split into three separate sections, with two motors connected to each section and supplied by two rectifiers. The three bus sections normally operate at the same voltage, however, provisions were made such that any of the sections could be operated at reduced voltage and permit the rolling of schedules requiring a wider speed cone than that provided by the shunt field ranges of the individual motors.

"PLATE MILL DESIGN AND ROLLING PRACTICE"

by Elmer Lynch, Superintendent Plate Mills and Tank Head Dept., Sheffield Steel Corp., Houston, Texas

ELMER LYNCH

▲ PRODUCTION of plates at the Houston plant began in 1942, one and one half years after construction of a fully integrated steel plant was started on a six hundred-acre tract adjoining the ship channel.

The first producing unit was a 22 × 34 × 112-in., three-high mill. A second three-high mill was leased by the DPC in 1943 and operated by Sheffield until the end of the war. In 1950, a three-high, four-high mill began operations. This mill was built to provide more and larger plates needed when Sheffield, together with A. O. Smith Co. of Milwaukee, formed a company for producing pipe. At present this mill can roll all the steel allocated for plates.

Better tonnage, more uniform cross section, and higher recovery are obtainable by the four-high mill. This unit includes a two-high scale breaker, a three-high rougher, and a four-high reversing finishing mill. There is a complete communications system with outlets at all operating stations and in the mill office.

Slabs are heated in two automatic gas-fired furnaces rated at forty tons per hour. The 116-in., three-high rougher operates at 48.5 rpm. The tilt tables are disc type with tilting angle fairly well divided between the up and down position. Adjustable side guards help avoid some of the evils that go with tilt tables.

The four-high finishing mill is 36 × 54 × 130-in. reversing with twin-motor drive. Power is supplied by a 6000-hp motor rated at 357 rpm with an eighty-ton flywheel. Mill tables are speed matched with the mill. The movement of the side guards automatically follows that of the mill. An electric eye records the temperature as the piece comes in from the three-high and also after each pass.

Finished plates pass through an open annealing furnace. This produces a more workable plate, particularly on wide, light gage products.

Plates up to ¾ in. are end trimmed in the first shears to give square entry to the rotary side trimming shears, then go to final end cut shears with an electrically operated length gage. Plates over ¾ in. go to a heavy duty side and end trimming squaring shears.

"SCREWDOWN LUBRICATION"

by William A. Holt, Eastern District, Brooks Oil Co., Philadelphia, Pa.

▲ PRESENT heavier loads and higher speeds have given the operator many difficult problems in the proper and economical lubrication of screwdown screws

and nuts. As a result of extensive studies on this problem, it has been determined that for proper operation, the lubricant must possess high film strength, good adhesiveness, low pour point, excellent wetting characteristics and be non-corrosive. It has been found also that viscosity is extremely important since the film must take the rubbing action and shock loads without breaking down the film. The lubricant must also flow slowly to prevent waste or excessive consumption.

The use of extreme pressure lead naphthenate lubricants has helped very markedly in overcoming screwdown problems. As an example, in one mill temperatures were reduced about 25 F in switching from a compounded cylinder oil to the lead naphthenate lubricant. In addition, consumption was reduced from 8 gallon per screw per turn to 1 gallon per screw per turn. Life was also increased at least three times. Most of the high speed mills have found that 250 SSU at 210 F viscosity is logical in summer and acceptable in winter although 160 SSU at 210 F viscosity is used by a number of mills in the winter.

"COLD REDUCTION FACILITIES AT FAIRLESS WORKS"

by Robert R. Shedd, Design Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

R. R. SHEDD

▲ FACILITIES installed by U. S. Steel Corp. at the new Fairless works consists of a 21 and 53 × 48-in. five-stand tandem mill, and a 21 and 56 × 80-in. four-stand tandem mill. The five-stand mill has a total of 21,650 connected horsepower and a maximum rolling speed of 7000 fpm, and the four-stand mill, having the same horsepower on the main drives, has a maximum of 3110 fpm.

There are several features incorporated in the design of these mills worthy of note. The five-stand mill has been provided with dual strip and roll coolant systems, thus enabling production with either a flood rolling solution type of coolant, or direct application of palm oil, the latter in conjunction with relatively high pressure water. The four-stand mill can also be rolled on the flood rolling solution type of system or on water, as dictated by operating requirements. In the latter instance, a third option is also provided, that of using rolling solution on the first three mill stands and water on the fourth or last mill stand, and is being used where product surface cleanliness is particularly desirable.

Both mills are equipped with similar coil preparation and feeding devices. These consist in sequence of an entry pallet-type conveyor, coil stop and lowering device, driven coil positioning rolls for rotating the coil, entry pinch rolls, and coil box having rotating side guides, hoist and stub mandrels. The mill proper is equipped with oil film bearings on the back-up rolls, roller bearings on work roll necks, hydraulically-operated wide opening hold-down boxes, and universal mill spindles. Tension reel mandrels have 16½-in. expanded diameter on the five-stand mill and 24-in. expanded diameter on the four-stand mill. The latter mandrel was provided with 1½-in. collapse to improve stripping action.

The five-stand mill delivery equipment includes an electronic scale integral with the coil stripper buggy, and 40 feet of apron conveyor. On the four-stand mill, delivery equipment includes in addition to an electronic scale and pallet conveyor, a down tilter and double strand conveyor for positioning and storage of coils with axis in a vertical position.

Hydraulic systems include static weight-loaded accumulators operating at pressures of 950 psi for auxiliary services and 2720 psi and 3625 psi for roll balance services on the five-stand and four-stand mills respectively. All operating valves on the axuiliary systems are pilot operated. Due to the physical arrangement of the two mills it was possible to centrally locate the hydraulic power equipment in the basement area housing rolling solution and lubricating systems. A total of eight oil systems are required to lubricate back-up roll bearings, twin gear drives, pinion stands and electrical rotating equipment, exclusive of dual centralized grease lubrication systems.

To protect an appreciable expenditure in material and equipment located in basement areas, a low pressure carbon dioxide fire extinguishing system was installed, sectionalized with necessary controls and fire doors in seven areas or zones to effectively isolate each area from an adjoining area.

The fog exhaust systems consist of dual eliminators and 80,000-cfm fans for both mills. Ventilation systems are comprised of precipitators for delivery of clean exterior air, and blowers having a total capacity of 480,000 cfm for the two facilities.

"IRON FROM CERRO BOLIVAR"

Talk and Movie by John L. Young, Vice President, Engineering, United States Steel Corp., Pittsburgh, Pa.

JOHN L. YOUNG

▲ CONCURRENT with the construction of the new Fairless works, U. S. Steel built the facilities for the mining, transportation, stockpiling, and ship loading of iron ore in Venezuela.

A thirty minute colored moving picture will be shown of the construction of those facilities, the loading of the first ship in Venezuela, and the arrival and unloading of that first ship at the Fairless works.

"ENGINEERING CONCEPTION OF FAIRLESS WORKS"

by J. D. Rollins, Assistant Vice President, Engineering, United States Steel Corp., Pittsburgh, Pa.

▲ FAIRLESS Works stands today as an exemplification of engineering achievement. True, United States Steel Corp. had been planning a plant on the

Eastern Seaboard for a number of years, but the invasion of Korea and a deteriorating international situation were responsible for accelerating the time schedule. Construction started with the ground breaking on March 1, 1951.

J. D. ROLLINS

A project of this magnitude afforded engineering challenges and opportunities seldom encountered in the steel industry. To cope with this situation, United States Steel Corp. brought together experienced personnel from its widespread divisions and plants. This group in turn engaged numerous consultants and other engineers from the industry suppliers, all of whom contributed information toward the final realization of the project. While nothing at Fairless works is a radical departure from proven facility designs, the plant does represent the concentration of the latest ideas in equipment and production procedure.

While the opportunity to "start from scratch" combined with the accumulated "know-how" of the industry lent themselves to the design and construction of the plant, the engineering was by no means a routine matter of selection and location. Unique problems in excavation, drainage, water supply, waste disposal, air pollution, as well as the design of operating equipment had to be solved.

The ever-proved combination of knowledge and experience met the challenges and the result — today's most modern integrated steel plant.

"PERFORMANCE FACTORS AFFECTING BAR MILL COOLING BED ARRANGEMENT"

by E. C. Peterson, Engineer, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

▲ THE paper discusses factors which affect the length of mill runout table to the cooling bed, as well as those which affect the cooling capacity and the cold bar shearing capacity. Some data is also given which is pertinent to these factors.

"MODERN CONTINUOUS WELD PIPE MILL"

by L. V. Johnson, Chief Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

L. V. JOHNSON

▲ EFFORTS to develop improved methods of manufacturing butt weld pipe have been unceasing since 1825 when the first butt weld pipe was produced. The evolutionary trend has been continued at the Fairless works of National Tube Division, United States Steel Corp., where the utilization of the stretch reduction principle permits the production of ½ to 4-in. pipe from a relatively few skelp widths.

In processing, slabs are delivered from an open slab storage yard to slab separating skids by crane and thence to a furnace charging conveyor from which the slabs are pushed into the heating furnace by means of a track-mounted charging ram. The slab heating furnace is of the side-charged, side-discharged, zone-controlled, double-fired type.

After heating, the slabs are conveyed to the skelp mill which consists of ten individually driven horizontal stands and five edging stands.

Skelp rolled on the skelp mill for subsequent coiling is delivered alternately to two parallel apron-type conveyors, thence to the skelp reels, to coil conveyors and to storage.

From storage, the coils are delivered to the two continuous butt weld mills, one converting skelp into ½ to 1½-in. pipe, while the second mill has a range of 1¼ to 4-in. pipe.

Conventional means are employed up to the welding of the pipe. Deviation from past practice results in the reducing mill where the diameter of the welded pipe is reduced and the wall thickness is maintained or reduced by stressing the pipe in tension between roll stands.

After sizing, cooling and sawing to required lengths, the pipe is transferred to the galvanizing department or finishing floor.

Two pipe galvanizing units have been provided, one being a batch-type for ½ to 4-in. pipe and the second being a continuous type for handling ½ to 2-in. pipe.

At the finishing floor, the pipe is threaded, tested, coated and bundled after which it is transferred to the warehouse for stocking and shipping.

! REMEMBER THE INSPECTION TRIP !

WEDNESDAY, MAY 5

FAIRLESS WORKS, U. S. STEEL CORP.

By E. E. VONADA, Applied Engineering Dept., Reliance Electric and Engineering Co., Cleveland, Ohio

UNUSUAL ELECTRIC DRIVE FEATURES APPLIED TO FAIRLESS PROCESSING LINES

. . . . paper presented before AIEE Winter General Meeting, New York, N. Y., January 22, 1954 . . . .

▲ THE electric drive innovations that have been put into operation at the fabulous Fairless Works of the United States Steel Corp. may seem insignificant when compared to the overall project, yet they are important from the standpoint that the resultant production equipment shows the handiwork of steel experts.

United States Steel Corp. experts from engineering, production, and maintenance groups combined their talents and projected their thoughts into the future when specifying the results to be expected from the processing equipment to be described. Certainly the theme of "maximum production of quality product with minimum manpower" could not be more fully exemplified.

It is not the intention of this paper to discuss regulating and control systems in detail, nor will the many automatic operating features so necessary for operator's convenience and manpower reduction be discussed. The illustrations of this paper will cover the sequential arrangement of the mechanical units in the processing line, and the generating and booster systems employed to apply adjustable voltage power to the strip propulsion unit drive motors, placing emphasis on sectionalization, tandem operation, with particular emphasis being placed upon novel systems employed to provide operating flexibility.

The following presentation sequence is arranged according to normal flow of hot strip coils through the processing lines.

The steel scale formed on the surface of steel strip after heating and hot rolling must be removed before strip gauge or thickness can be reduced in the cold reduction mills. Scale removal is most commonly accomplished in a pickle line where the scale is remove l by a combination of mechanical and chemical action.

Scale breaker or process units accomplish the mechanical part of the job by bending or otherwise deforming the strip surface. The scale, being very brittle and hard, has no elasticity so strip deformation results in scale flaking and cracking, thereby exposing the base metal to chemical erosion in the acid solution. It is axiomatic to say that the time required to remove the scale in the acid solution varies inversely with the number of scale particles per unit surface area.

Figure 1 shows the schematic layout of the Fairless pickle line designed to handle steel strip having width

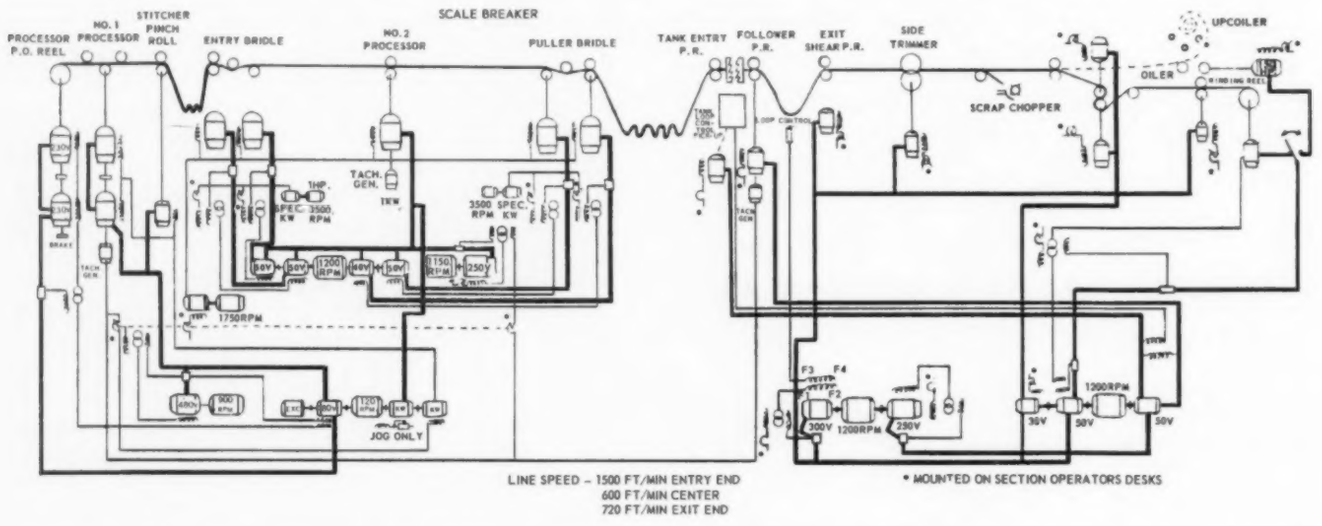


Figure 1 — The 80-in. continuous strip pickle line at Fairless was designed to handle widths from 18 to 74 in. and lengths from 0.06 to 0.25 in.

variations of from 18 to 74 in., and thickness variations of from 0.060 to 0.250 in. The strip flows from left to right with coils to be processed being introduced either from a cone type payoff or a stationary mandrel at the discretion of the operator. The strip then passes through the No. 1 processor or scale breaker, a welder, a flash trimmer, and through a stitcher pinch roll into a storage loop.

The strip propulsion drives constitute the entry section of the line. Since considerable downtime is involved in joining the coils in this section either by welding or stitching, and since it is imperative to keep the pickling section operating at maximum speed continuously from a quality standpoint, the drive arrangement and gearing in speeds had to be carefully considered.

Tandem motors were used for the No. 1 processor and payoff drive to minimize inertia, and maximum rates of acceleration and deceleration are obtained by utilizing current limit regulated control with the common generator supplying adjustable voltage power to all the motors in this section. The combination of the generator, booster, and control is arranged to provide for simultaneous independent jogging of each unit so necessary for the welding, trimming and stitching operations.

From the storage loop, strip flow is through the second scale breaker section comprising entry pinch roll and bridle, No. 2 processor, and delivery pinch roll and bridle combination. All drive motors for the units in this section receive adjustable voltage power from a common generator, which is again arranged through a regulator with current limit accelerating and decelerating control. Independent boosters and torque regulators for each pinch roll and bridle drive motor are employed to permit maximum operating flexibility.

Under normal operating conditions, the No. 2 processor sets the operating speed of this section. Magnitude of entry and delivery tension as well as desired distribution of total tension between the pinch roll and bridle is independently adjusted by the operator. When the No. 2 processor is not required for a particular product, the delivery pinch roll alone is used to propel the strip between the two storage loops.

This section must, of necessity, operate at an average speed between the continuously running pickling section, and the frequently stopped and overspeeded entry section in order to maintain equal strip storage in the two storage pits. This operating condition is automatically provided for by applying the summation voltage of the tachometer generators driven by the pickling section follower pinch roll motor and the No. 1 processor motor. It is also possible for the operator to transfer strip storage from one pit to the other, or to cause the scale breaker section to operate in synchronism with the pickling section automatically.

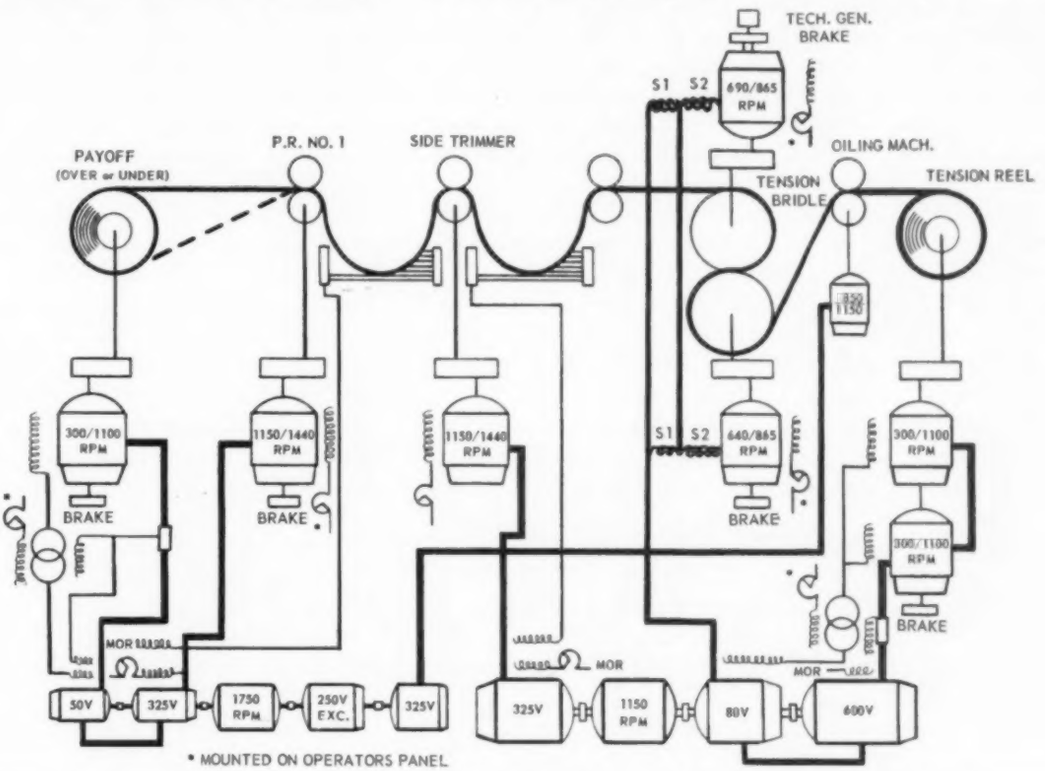


Figure 2 — The 80-in. side trim and recoil line was designed to process 50,000-lb coils.

To provide for the extremely wide product gauge and width variation, it was expedient to cover a part of the line operating speed range at constant horsepower. Since the constant horsepower range for this section was less than for the entry section and since it was necessary to modify the fields of all the motors in the section simultaneously and with approximately equal magnitude, it proved advantageous to supply independent motor field exciters for each of these sections because of the relatively simple three plate manual rheostat stacking.

The strip propulsion units in the pickling section of the line consist only of the follower and entry pinch roll. The drive motors for these units both receive adjustable voltage power from a common generator arranged for current limit acceleration and deceleration through a regulator. A booster is employed in conjunction with the entry pinch roll drive motor to provide for strip catenary maintenance in the pickling tanks

through the utilization of a non-contact type loop control system.

Out of the loop following the pickling section the strip passes through an exit shear pinch roll, side trimmer, to either an upcoiler, or a bridle and winding reel combination.

Here again all drive motors in this section receive adjustable voltage power from a common generator that is excited from a voltage regulator with current limit accelerating and decelerating control. Since the loop between this section and the pickling section has relatively small storage capacity, it is necessary that these two sections be operated in close speed synchronization.

To provide for this a modulated loop control system is applied to the generator voltage regulator to modify exit section speed as necessary to maintain speed relationship. This section must, of course, be overspeeded after it is stopped to remove a completed coil in order to restore the loop to its normal operating level.

When processing the heavier gauge strips the upcoiler is used to form a coil, whereas when processing light gauge strip the combination tension bridle and tension reel are used for recoiling the strip. Selection of either operating condition is readily available to the operator.

Pickled coils normally are finish processed in the flat products department or the tin finishing department. Processing of coils in the flat products or sheet finishing department normally involves shearing and trimming or trimming, slitting and recoiling operation. Let us next consider a line designed to perform the latter function.

Figure 2 shows the sequential arrangement of units comprising the 80-in. side trim, slitting and recoil line at the Fairless Works. It is designed to process 50,000-lb coils having a diameter range of from 24 to 72 in., with strip ranging in width from 18 to 74 in. and having a gauge range of from 0.074 to 0.025 in.

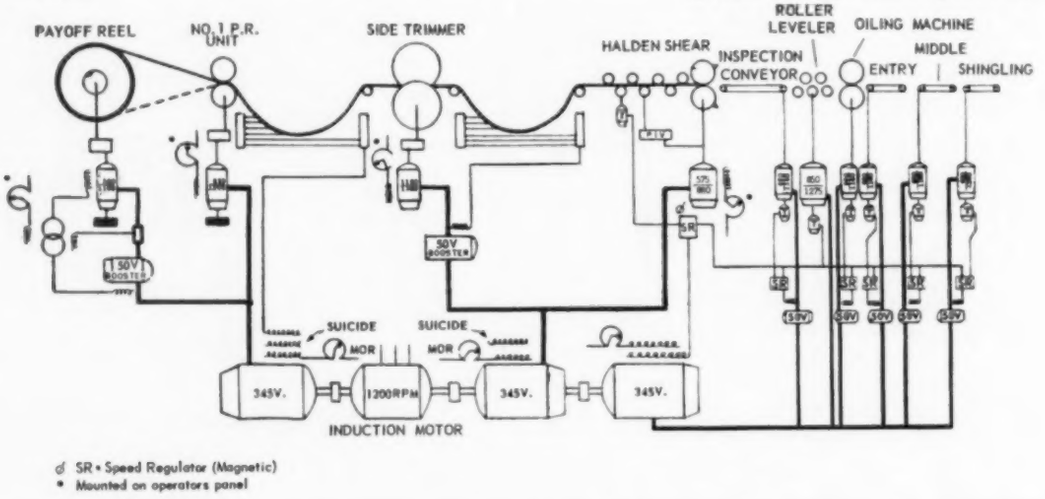
At first glance one may get the impression that there is excessive generator and booster equipment applied to this line. This is not the case, however, for the line must operate with loops as indicated in the sketch or as a tight line between the payoff reel and the tension bridle.

The bridle is considered the pace setter for the line for both operating conditions. When operating with loops, the payoff reel and the No. 1 pinch roll motors must have their speeds modified simultaneously to maintain loop between pinch roll No. 1 and the side trimmer at the prescribed level. This is accomplished by utilizing a separate generator for these two units and modifying that generator voltage by the loop control. In order to assure tension maintenance between the payoff reel and the No. 1 pinch roll, a booster is connected in the payoff armature circuit to modify applied armature terminal voltage to the payoff drag generator as is necessary to maintain preset tension.

This booster also provides for inertia compensation during speed change. The side trimmer motor receives adjustable voltage power from its own generator which is designed with multiple fields to provide for maintenance of a loop through automatic loop control acting upon the auxiliary field of the generator, and to provide for a latitude of adjustment for tight line operation.

The tension bridle and tension reel drive combination is quite conventional in that a single generator applies adjustable voltage power to the two motor armatures, while the booster in the bridle motor armature circuit, having its field modified by the reel tension regulator, provides for maintenance of tension, and stall current conditions between these two units. Attention is called to the series field connections of the two bridle units, which are designed to inherently maintain automatically the differential load relationship between these two units.

As previously mentioned, the loops in the No. 1 pinch roll are electrically and mechanically removed from the system for tight line operation between the payoff reel, side trimmer and tension bridle. With the generator and booster system employed, transfer is made with minimum transfer control equipment.



ⓓ SR • Speed Regulator (Magnetic)
• Mounted on operators panel

Figure 3 — Schematic layout of 80-in. side trim and shearing line.

Figure 3 shows schematically the layout for an 80-in. side trim and shearing line designed to handle coils weighing up to 50,000 lb with diameter range as previously covered by the recoil line. Strip width range varies from 30 to 72 in., and gauge varies from 0.025 to 0.074 in. Cut sheet lengths vary from 42 to 180 in.

The main drive arrangement for all the equipment up to the classifying section is conventional and needs no further amplification. The piling section drive is not conventional, however, and is certainly worthy of some elaboration.

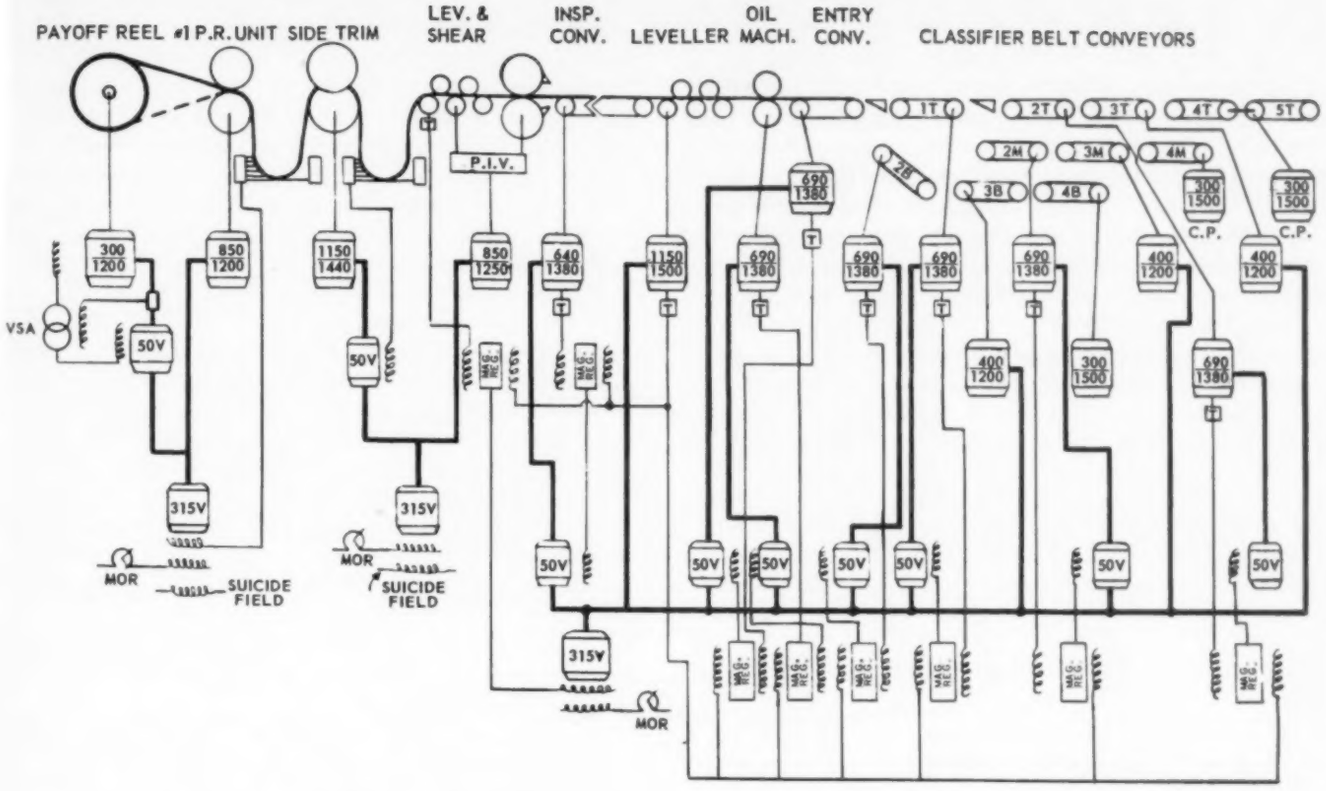
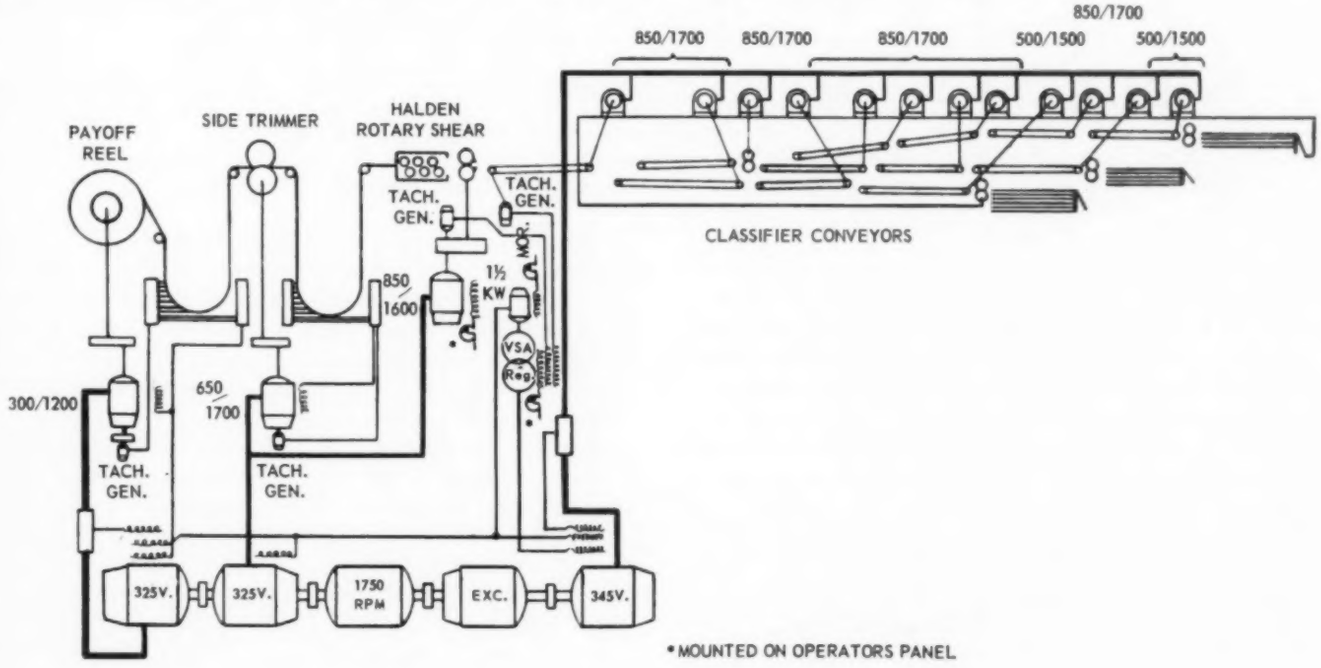


Figure 4 — The 56-in. side trim and shearing line is designed to handle the same diameter coils as the 80-in. line.

Operators frequently complain about inability to maintain speed relationship between piling sections when changing line speed, as well as the necessity to readjust the relationship between belts after ultimate line speed was reached. The U. S. Steel Corp. representatives instrumental in specifying operations to be expected from this line were also very familiar with this problem and did everything possible in attempting to alleviate this condition; for speed regulators are provided for each drive unit in the conveying and piling sections.

All motors in this section—including the leveler—receive adjustable voltage power from a common generator. The voltage of this generator is maintained at the necessary level to satisfy a speed regulator having intelligence provided by a tachometer driven by a leveler roll on the shear opposed by a feed back signal from a tachometer generator driven by the roller leveler drive

Figure 5 — The 40-in. side trim and shear line was designed to handle 36,000-lb coils.



motor. This relationship is, of course, made adjustable for the operator.

The roller leveler tachometer generator sets up a speed reference for speed regulators on all the other units in this section. These speed regulators act upon booster fields in the respective motor armature circuits to insure maintenance of speed relationship over a wide operating speed range. Here again the operator is provided with facilities for adjusting desired speed relationship between units to get desired piling operation. This is the ultimate in piler belt drive systems.

Figure 4 shows the drive arrangement for the 56-in. side trim and shear line arranged to handle the same diameter coils as did the 80-in. line. The strip width range for this line is 18 to 48-in., while the gauge range is 0.012 to 0.074 in. Sheared sheet lengths vary from 30 to 144 in. Here again, as for the 80-in. line, the drive system for the main units through the shear is conventional and needs no further discussion.

From the shear on, however, speed regulators are employed to maintain preset speed relationship between, in this case, classifier belts, for on this line classified piling is obtained. The regulating system is similar to that described for the 80-in. line, and further clarification is not necessary. From the electrical drive standpoint, this system approaches the ultimate in that the most important classifier belts are speed regulated.

Moving to the alternate normal coil destination, namely the tin finishing department, the first processing line to be considered is the 40-in. side trim and shear line having mechanical and drive arrangements as shown in Figure 5.

This line is designed to handle 36,000-lb coils having a diameter range of from 16½ to 72 in. with a trimmed width range of from 18 to 38 in., a gauge range of from 0.006 to 0.025 in., and a sheared sheet length range of from 18 to 43 in. On this drive the payoff reel powering arrangement is slightly non-conventional in that a separate generator is provided for this unit alone.

Conventionally a single main generator is employed to supply adjustable voltage power to all units on the shear line, with boosters used in conjunction with the payoff reel, side trimmer and classifier belt drive motors. The coil diameter range and the wide operating voltage range forced us to move away from the conventional drive system.

The classifier belt drive is also non-conventional in that we have an individual generator applied to this group of motors. The wide operating speed range combined with the speed regulating system applied between the shear and the shear belt caused us to move to a separate generator application. The application of a single speed regulator in this manner has certainly proven to be a good method to reduce classifier cobbles which would normally result because of variable belt speed relationships.

Part of the product from the shearing line is tin coated in dip tinning lines that are non-conventional in that adjustable voltage generators are applied to drive motors on the feeders and the pot drive itself. Tin plate from the dip lines as well as the electrolytic tinning line is assorted on the inspection lines, which again are equipped with adjustable voltage drive systems.

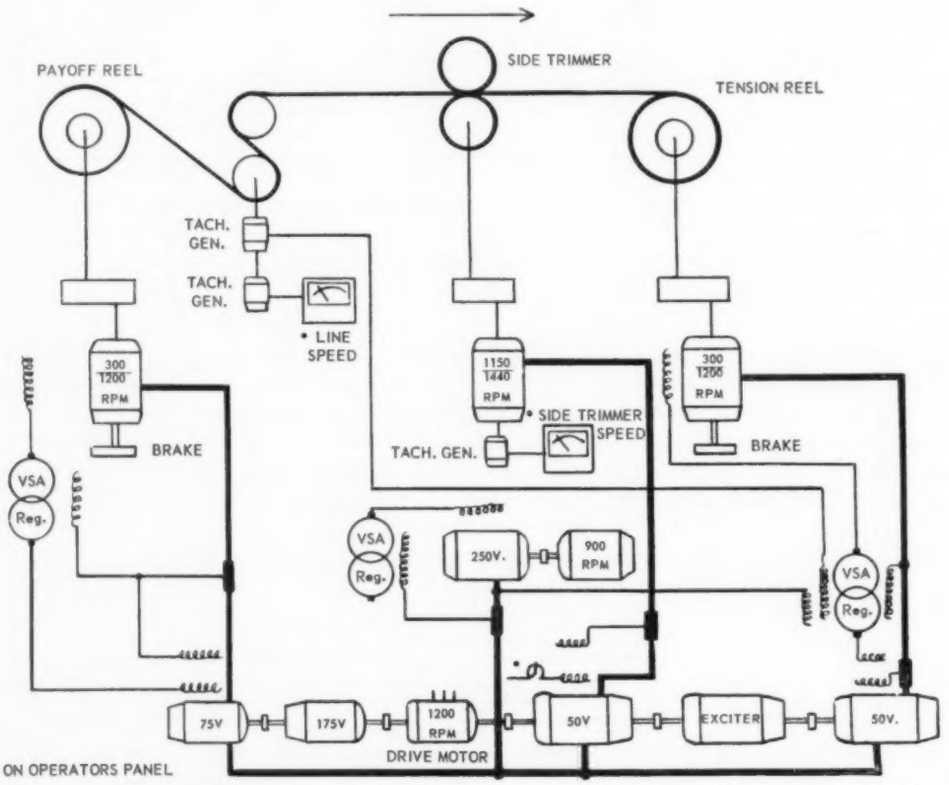


Figure 6—A number of difficult drive problems had to be overcome to meet the wide range of products to be processed on the 40-in. side trim and recoil line.

Another processing line in the tin finishing division to be considered is the 40-in. side trim and recoil line or coil preparation line shown schematically on Figure 6.

The mechanical arrangement emphasizes maximum simplicity, but one can readily appreciate some of the drive problems when one realizes that this line is designed to process 36,000-lb coils having a coil diameter range of from 16½ to 72 in., a trimmed strip width

variation of from 18 to 38 in., and strip gauge range of from 0.006 to 0.025 in. over a speed range of from 0 to 4000 fpm.

The drive motors of all units receive adjustable voltage power from a single generator having its voltage controlled by a voltage regulator designed with accelerating and decelerating current limit control. This basic control system provides very rapid accelerating and decelerating control so necessary for this type line since it is on this line that several small coils are joined together to form a big coil necessary for future processing. Since the coil ends are joined together in a welder on this line, it is important to the operator to have almost infinitely variable speed control available at his fingertips to facilitate coil end spotting in the welder.

Field current of the windup reel motor is modified by a speed regulator designed so that it changes the motor field as required to maintain a balanced regulator condition between main generator armature voltage, and that of a tachometer generator driven by a billy roll in contact with the strip. Maintenance of this regulated speed is necessary in order to retain preset speed relationship between strip speed and trimmer knife peripheral speed. The payoff reel drag generator field strength is modified by a current regulator to maintain the necessary tight strip between the two reels at all times.

Boosters are used with each motor drive to provide extension of the reel motor field ranges for coil diameter variation, and to produce necessary torque variation for acceleration and deceleration. The trimmer booster is employed to permit modification of speed relationship between trimmer knives and strip, and to provide for accelerating and decelerating inertia compensation.

Completed coils from this line then proceed to the electrolytic tinning line where 385 hp in adjustable voltage drive systems is utilized for strip propulsion through this processing unit.

In conclusion, the processing lines just described are only a small part of the complete plant. It is indeed a fabulous project.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Saturday, May 22, 1954 — Annual Picnic.

Pearl Lake, Birmingham, Ala.

▲

CHICAGO SECTION

Tuesday, May 4, 1954 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Coil Annealing Symposium."

Speakers:

John Soyring, Gary Sheet and Tin Mill, United States Steel Corp., Gary, Ind.

W. F. Carter, Assistant General Superintendent, Acme Steel Co., Chicago, Ill.

Horace B. Helm, Fuel Engineer, Chicago District, Indiana Harbor Works, Youngstown Sheet and Tube Co., East Chicago, Ind.

W. H. Swisshelm, General Foreman Electric Tinning, Tin Mill, Inland Steel Co., East Chicago, Ind.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Friday, May 14, 1954 — Golf Party.

Acacia Country Club, Cedar Road, Cleveland, Ohio.

▲

YOUNGSTOWN SECTION

Monday, May 24, 1954 — Social Hour 5:30 P.M., Buffet Supper 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip — 1:30 P.M., Ohio Works, United States Steel Corp., Youngstown, Ohio.

Reservations must be made to J. F. Hall, Youngstown District Secretary, AISE, 208 Diana Drive, Poland, Ohio.

"Description of the New Ore Bridges at Ohio Steel Works," by Edward H. D. Gibbs, Contracting Engineer, Heyl and Patterson, Inc., Pittsburgh, Pa.

"Description of New Steam and Power Generating Facilities at Ohio Steel Works," by J. P. Katzenmeyer, Power and Fuel Engineer, United States Steel Corp., Youngstown, Ohio.

"Description of New Steam & Power Generating Facilities at The Ohio Steel Works" by R. W. Worley Engineer Manager, United Engineers & Constructors, Philadelphia, Pa., and J. P. Katzenmeyer Power & Fuel Engineers, Ohio Works, U.S.S. Corp.

Mural Room, VFW, 225 W. Boardman Street, Youngstown, Ohio.

THE MODERN ELECTRIC WELD PIPE AND CASING MILL

By NORBERT C. RUBIN
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. . . . constant improvements are being made in the design and construction of electric weld pipe mills . . . .

▲ THE ordinary sizes of steel pipe and casing have been produced by the electric resistance weld process for a number of years, starting originally in the Youngstown area. Those particular mills have been improved at various times but, obviously, limited to revisions which could be done without major rebuilding.

During the past five years, several new large electric resistance weld pipe mills have been built and put into operation. The most recent of these installations, and the one which will be discussed here, is at the plant of the Lone Star Steel Co. in Texas.

There are two complete tube forming and welding mills at Lone Star Steel, the smaller of which has capacity from 2 to 6⅝-in. outside diameter with wall thicknesses ranging from 0.125-in. minimum to 0.337-in. maximum, and speeds up to 150 fpm. The larger mill has a capacity from 4½ to 16-in. outside diameter with wall thicknesses varying from 0.125-in. minimum to 0.557-in. maximum and speeds up to 120 fpm. Within these ratings you will find practically all of the popular sizes and grades of line pipe, casing and oil country tubing.

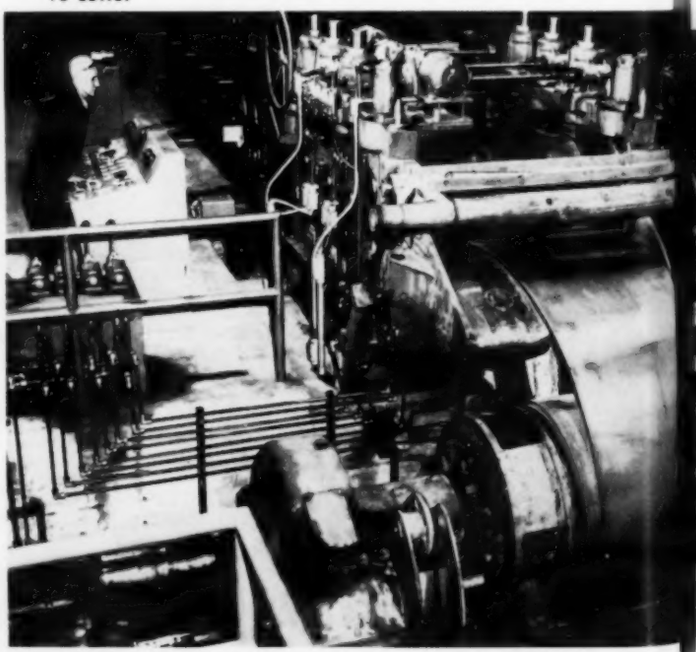
Basically, these new mills involve the same processes used in early mills of this type, but many improvements have been brought about which result in higher speeds, yields, and efficiencies. Also, these mills can make a definite claim of being the very first in existence to:

1. Produce casing from multiple width slit stock.
2. Use coil stock up to 0.375-in. thick.
3. Have a flying automatic rotary cutoff machine for 16-in. pipe.

These mills are located in two buildings each 75 ft wide and about 1900 ft long, but the entire space provided for the pipe mills and all finishing equipment is slightly more than 600,000 sq ft. This area does not include space for basic steelmaking equipment. Two ten-ton cranes service each of the buildings which are designed with a crane clearance of approximately 30 ft.

Both pipe mills are arranged for straight line high speed continuous production. Skelp and pipe are carried by conveyors through the various operations with no accumulation at any point except on the cooling bed after normalizing. In fact, when coiled stock is being run, a number of operations are performed simultaneously on the long strip as it progresses through the mill line.

Figure 1 — A double head expanding drum type uncoiler is used which has the capacity to receive coils up to 16 tons.



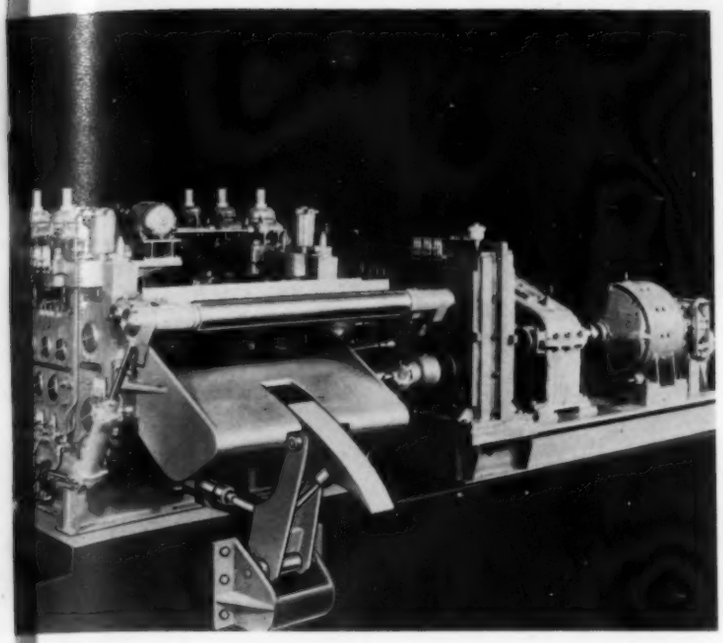


Figure 2 — The flattener consists of one pair of feed rolls and nine ordinary staggered rolls, five above and four below.

For purposes of illustration and more detailed description, the larger of the two Lone Star pipe mills will be discussed in this paper.

The entry end of the mill line is designed to accommodate both plate and coils. In the case of plate, the material is transferred sidewise, one plate at a time, from the adjacent building on a chain conveyor. In the pipe mill building the plates are deposited onto a roller conveyor at right angles to the transfer which starts the plate into the line. This conveyor bridges the uncoiling apparatus which, of course, is idle when plates are run.

Coiled stock is provided by the hot mill which is equipped to make coils up to $\frac{5}{16}$-in. thick in J55 casing material and $\frac{3}{8}$-in. thick in line pipe material. These coils are brought from the hot mill by roller conveyor to a cooling area and then to the pipe mill. At this point an upender orients the coil and deposits it in the uncoiler. This is a double head expanding drum type uncoiler (Figure 1) with capacity to receive coils weighing 16 tons. This unit is equipped with a hydraulic elevator to raise the coil to proper position before the drums seize it. At this point a spade moves into place to peel off the outer layer of the coil so that the drive on the drums will feed the end of the strip into the flattener.

The flattener (Figure 2) is a simple unit consisting of one pair of feed rolls and nine ordinary staggered rolls, five above and four below. Its purpose is mainly to remove coil curvature from the steel strip so it can be easily handled in succeeding units. Four of the top rolls are mounted in a common housing with driven screwdowns at entry and exit ends, providing rapid set-up and adjustment. In addition, the last or fifth top roll has a separate adjustment as a means of controlling the leading end of the strip to minimize "ski-noses" which otherwise can be a source of trouble in subsequent operations.

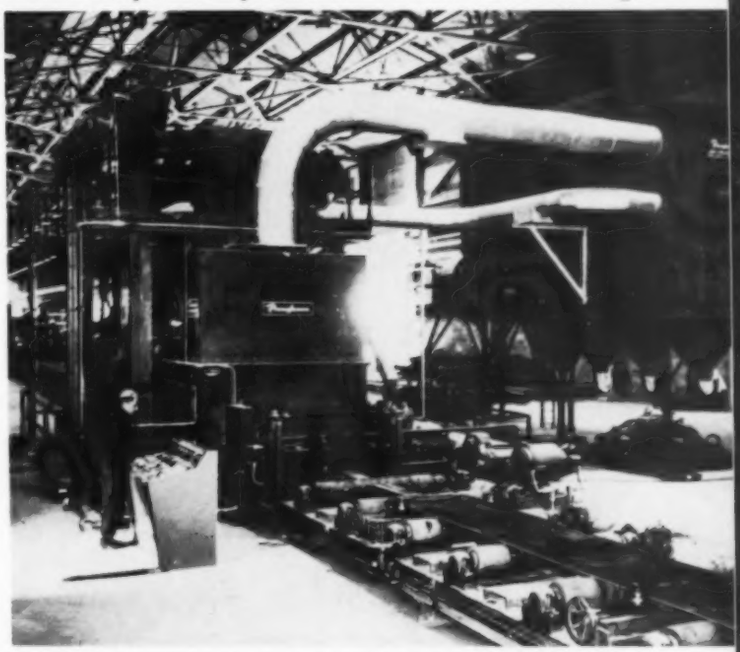


Figure 4 — The blasting machine is of the centrifugal type and uses iron grit which cleans several inches of surface at both edges of the underside of the plate.

A normal type of heavy upcut shear is the next item in the line, and is used to square both ends of plates and coils.

Beyond another flat plate conveyor is a rotary edge trimmer and scrap chopper (Figure 3). This machine is often called a housing mounted side or edge trimmer because each pair of circular cutting blades is individually mounted on stub shafts in a separate housing. These housings are adjustable with relation to each other through a large motorized screw. This machine trims the strip or plate to the exact width required for each size of pipe.

Following the side trimmer is a flat plate conveyor, a roto blast machine, and another conveyor. The

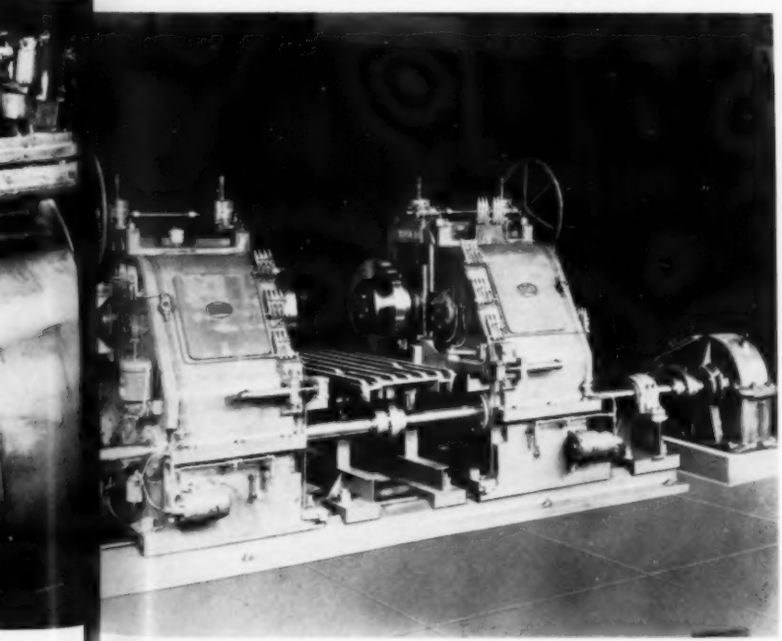


Figure 3 — The rotary edge trimmer and scrap chopper are located beyond a flat plate conveyor.

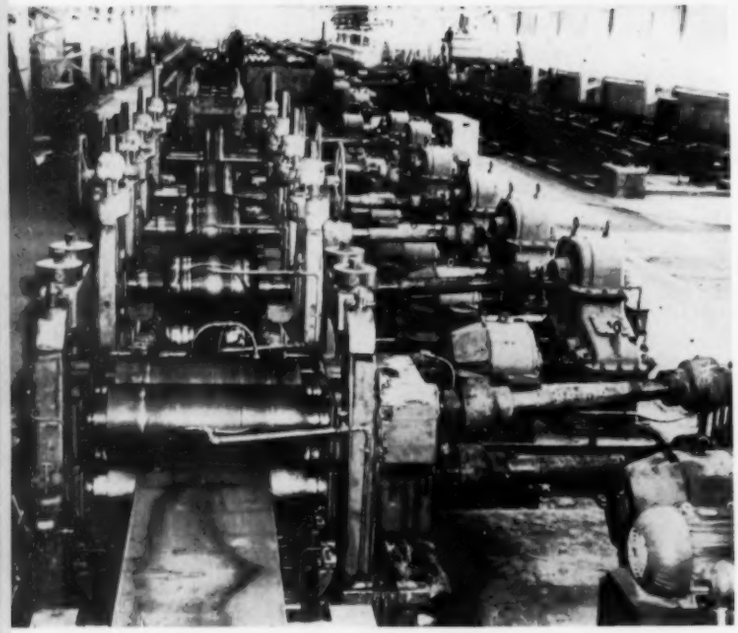


Figure 5 — The forming mill uses eight pairs of driven rolls and three pairs of idler rolls. All driven rolls have individual drives.

blasting machine (Figure 4) is of the centrifugal type, uses iron grit, and cleans several inches of surface at both edges of the underside of the plate. After forming, these surfaces contact the welding electrodes.

The forming mill (Figure 5) is an integral unit comprising eight pairs of driven rolls and three pairs of idler rolls. Each pair of driven rolls has a separate d-c motor to provide a smooth flow of strip through the

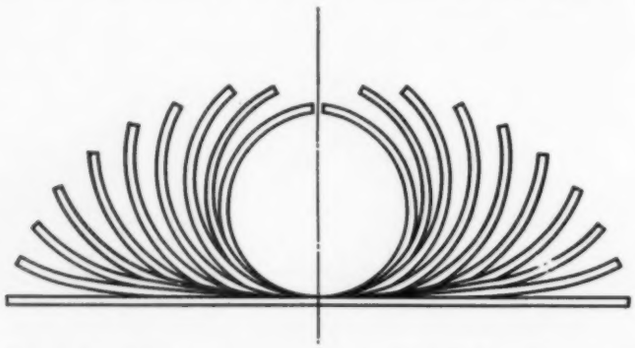


Figure 6 — Sketch shows progression of forming operation.

mill. All driven rolls are on horizontal shafts and idler rolls on vertical (Figure 6). This is a plan of forming procedure developed over a long period of years that is suitable for both pipe and casing materials. Obviously, the contour of each roll is quite important, but the ratio of roll diameter to size of pipe must also be carefully considered. Side idler rolls are used to assist in the early stages of forming, (Figure 7) but, in the final stages, vertical axis idler rolls are mounted in the same vertical plane with driven rolls, making a cluster of four. This arrangement practically eliminates any tendency to scuff the sides of the pipe, usually caused by large roll flanges.

The resistance welder (Figure 8) is the largest of its type in the world and is rated at 275,000 amperes, 16

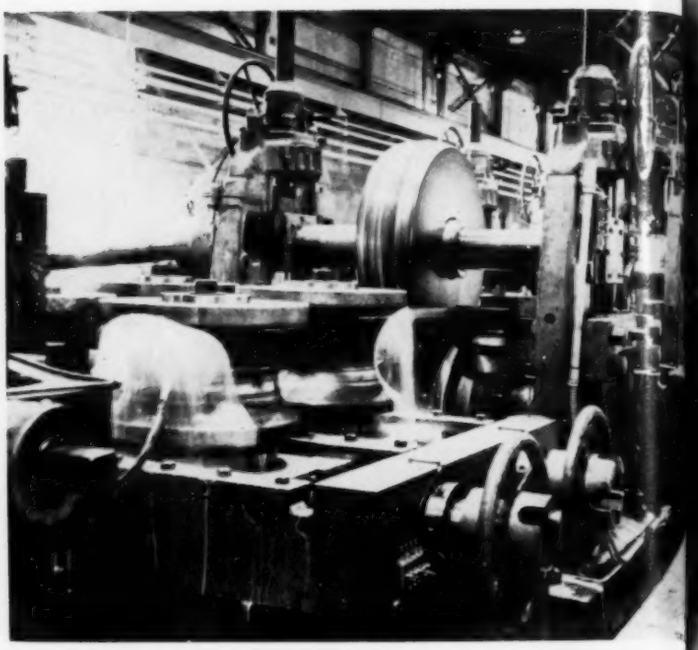


Figure 7 — In the early stages of forming, side idler rolls are used, but in the final stages only vertical idler rolls are used which are mounted in the same vertical plane as the driven rolls.

secondary volts or 4400 kva. The motor-generator set feeding this welder has a 4500-hp synchronous motor and a 4000 kva, 84-cycle single phase generator. Heat requirement at the welder is controlled entirely by regulation of the generator output. The transformer is water cooled and is mounted in a large rotor assembly which also carries the electrodes themselves. Motorized screwdowns adjust the position or pressure of the electrodes. A pair of driven squeeze rolls on vertical axes work in conjunction with the electrodes to accomplish the weld.

Included with the welder is a flash trim unit which cuts the welding flash from the outside of the pipe

Figure 8 — The resistance welder is rated at 275,000 amperes at 16 volts.

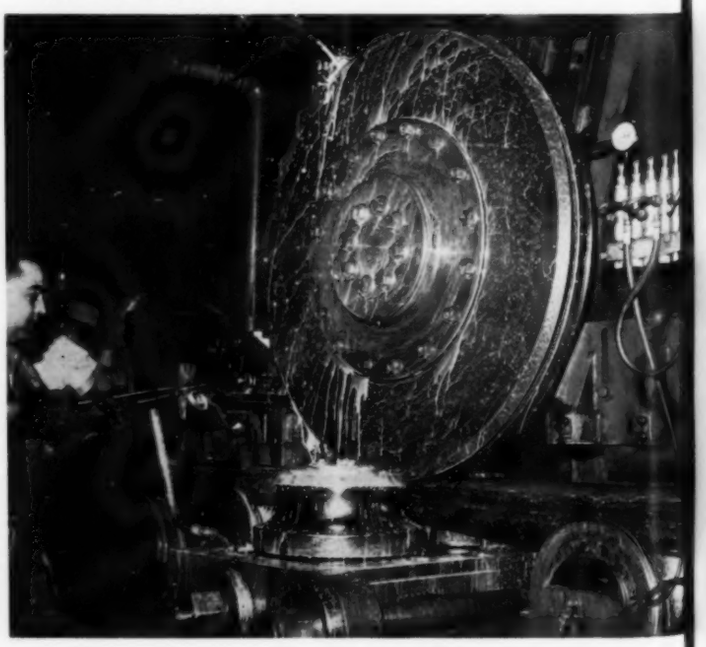


Figure 9 — The three-stand pullout unit has individually driven stands consisting of two driven and two idle rolls.

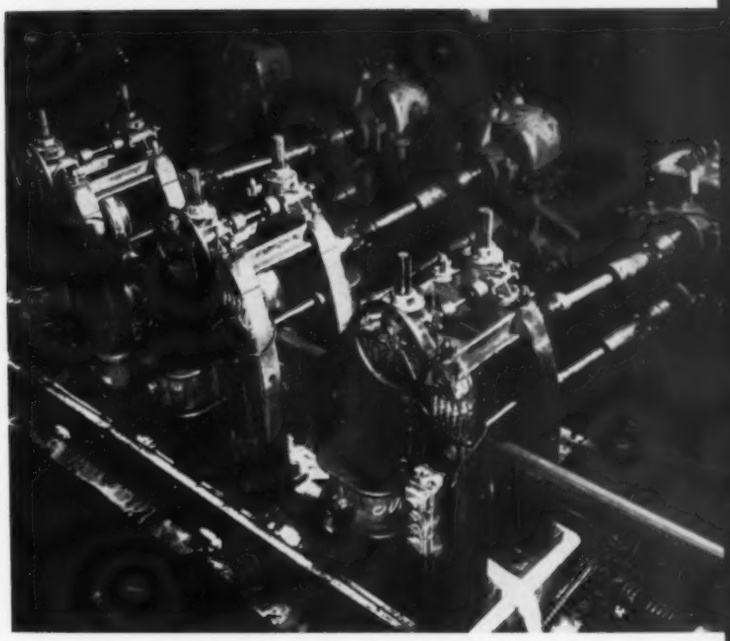


Figure 10 — A four-stand mill is used to cold reduce the pipe.

while it is still quite hot. A mandrel is also located at this point inside the pipe to remove the inner flash.

A 3-stand pullout unit (Figure 9) is used just beyond the welder. All 3 stands are individually driven and each stand is again a 4-roll cluster, two driven and two idle rolls.

An automatic rotary flying cutoff machine is next in line to cut the pipe, on the fly, to the required lengths. It is mainly hydraulic in its operation and uses disc cutters to sever the pipe.

A pinch roll and long driven conveyor succeed the cutoff machine. The pipe is carried out to a transfer bed from which it is passed through a rough straightener. This is a 3-stand machine similar to the pullout unit which merely straightens the pipe sufficiently so it will carry through a furnace and transfers.

The pipe is moved on skew roll conveyors through a gas fired, reflector type furnace at speeds comparable to the rate of welding. In this furnace, line pipe is brought up to a temperature of about 1400 F and casing to about 1600 F. Beyond the furnace, the pipe is laid on a cooling bed and allowed to cool below the critical temperature, after which it is further cooled by water spray preparatory to reducing. Ordinarily it is not required to normalize nor reduce line pipe, but it is being done in this instance to produce, first, a higher quality pipe, and, second, to be able to use the same rolls for both pipe and casing.

Cold reduction (Figure 10) is accomplished in a four-stand mill similar in construction to previous items described. Each stand comprises a four-roll cluster with top and bottom rolls driven. A total reduction of about 3 per cent is made here to produce physical properties required for casing without the need for extremely high chemistry which would otherwise be demanded.

Final operation in the continuous line is straightening, performed in a standard type of a cross roll machine. Now the pipe is ready for the finishing department.

Finishing operations comprise end cropping or facing, threading, hydrostatic testing, upsetting and painting. Pipe is carried between these operations by transfer tables and cranes. None of these functions involve any particularly new design of machinery but all equipment is adequate in performance and capacity to handle the maximum output of the mills.

Inspection is not a centralized function and must be carried on constantly, from start to finish of all operations in order to produce a maximum quality product.

For the moment, no radical change or improvement in this overall process is foreseen, although material differences can be found in each of similar mills built in the past six years. No doubt, the next mill will contain certain innovations but, today, the mill just described is the most modern in existence.

DISCUSSION

PRESENTED BY

J. H. GREENBERG, Assistant to President, A. J. Boynton and Co., Chicago, Ill.

J. H. Greenberg: The various suppliers are to be complimented for the excellent job they accomplished in designing and building the two electric resistance forming and welding mills for Lone Star Steel Co. We believe that this installation has proved without question that the API casing and tubing of grades at least up to J-55 can be successfully produced on this type of mill. We would like to put further emphasis, however, on some of the innovations of the large diameter mill at Lone Star Steel Co., because these innovations have been instrumental in upsetting past beliefs that J-55

casing could not be made on an electric resistance forming welding mill, and that J-55 casing could not be successfully made from slit skelp.

All pipe made on the small mill at Lone Star and the smaller sizes made on the large mill are produced almost entirely from triple slit skelp. This was done largely to increase rolling mill production by rolling in multiple widths where possible. With the careful control of analysis, segregation and gauge practiced at Lone Star, there has been no difficulty encountered to date caused by the use of slit material.

The addition of uncoiling and flying cut-off equipment to the large mill has resulted in an overall improvement of production and yield which has more than paid for the cost of the equipment. It is interesting to note that one manufacturer of large diameter, electric resistance welded pipe has already added such facilities to an existing installation, and others are now considering adding them to existing or proposed mills. Probably the key to the successful production of J-55 casing by this method is the addition into the line of production of normalizing facilities by means of which detrimental effects of welding are effectively removed. Since the normalizing is done before straightening and cold sizing, the cracking at the weld, which previously characterized the manufacture of J-55 casing by the electric resistance weld method, has not been a source of trouble at Lone Star. The work done at this company has proven in addition that the theory of rapid normalizing in a straight-through type of furnace is sound, and that satisfactory results can be obtained by heating to a temperature of about 1650 F followed by air cooling, with the entire heating cycle taking place in from three to six minutes, depending on wall thickness.

Finally, it should be noted that the Lone Star mill is the first to be completely conveyorized, providing for automatic handling from skelp to finished pipe. For this purpose, 17,000 lineal feet of roller conveyors and 2,000 lineal feet of transfer beds were provided. This has reduced rehandling to a minimum and permits the high production to be handled with a minimum of "in process" storage.

CONTROL FOR A MODERN ELECTRIC WELD PIPE AND CASING MILL

By C. E. SMITH
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Cutler-Hammer, Inc.
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. . . . mill is believed to be first unit built to continuously weld casing from multiple width skelp which can be either coiled or precut into plates . . . .

▲ THIS paper describes the electrical controls furnished for a large resistance welding tube mill installed at the Lone Star Steel Co., Lone Star, Tex. The greater part of this paper concerns only the controllers for the adjustable voltage d-c drives and the weld power source.

GENERAL DESCRIPTION

The No. 1 pipe mill at the Lone Star Steel Co. is a machine which produces line pipe and casing ranging from 4.5 to 16 in. outside diameter, and from $\frac{3}{16}$ to $\frac{9}{16}$-in. wall thickness. Pipe of wall thickness less than $\frac{3}{8}$-in. is produced continuously from coiled skelp, while pipe heavier than $\frac{5}{8}$-in. wall thickness is produced from skelp which has been precut to length in a strip mill. The mill is capable of handling $\frac{3}{8}$-in. skelp in either form precut or coiled.

The forming and welding mill consists of an uncoiler for uncoiling the skelp, a leveler for straightening the uncoiled skelp or precut plates, an upcut shear for end cropping, a side trimmer, a shot blaster which prepares the skelp edges for welding, and a forming mill consisting of 10 forming stands which gradually form the skelp into a continuous open tube. After the tube is formed, it is passed under weld wheel electrodes consisting of two insulated discs of copper which straddle the seam of the tube. The open tube is continuously welded into pipe at speeds of 40 to 120 fpm as the ma-

terial passes under the electrodes. A pair of squeeze rolls under the weld wheel electrodes forces the seam of the formed skelp together with terrific pressure. Since the skelp edges have been shot blasted, the contact resistance of the seam is very low after pressure is applied, allowing the greater part of the weld current to flow through the tube seam. A 4000-kva power source is connected to the weld wheel electrodes. The inside and outside flash is trimmed as the pipe emerges

ADJUSTABLE VOLTAGE CONTROLLERS

The mill drive for the entire pipe machine from the precut plate conveyor to the final reducing and sizing machine is an adjustable voltage d-c system except for the pipe manipulators, cooling bed conveyors and furnace by-pass conveyors which are a-c drives (see Figure 1). Two d-c drives, the upcut shear and the rotary

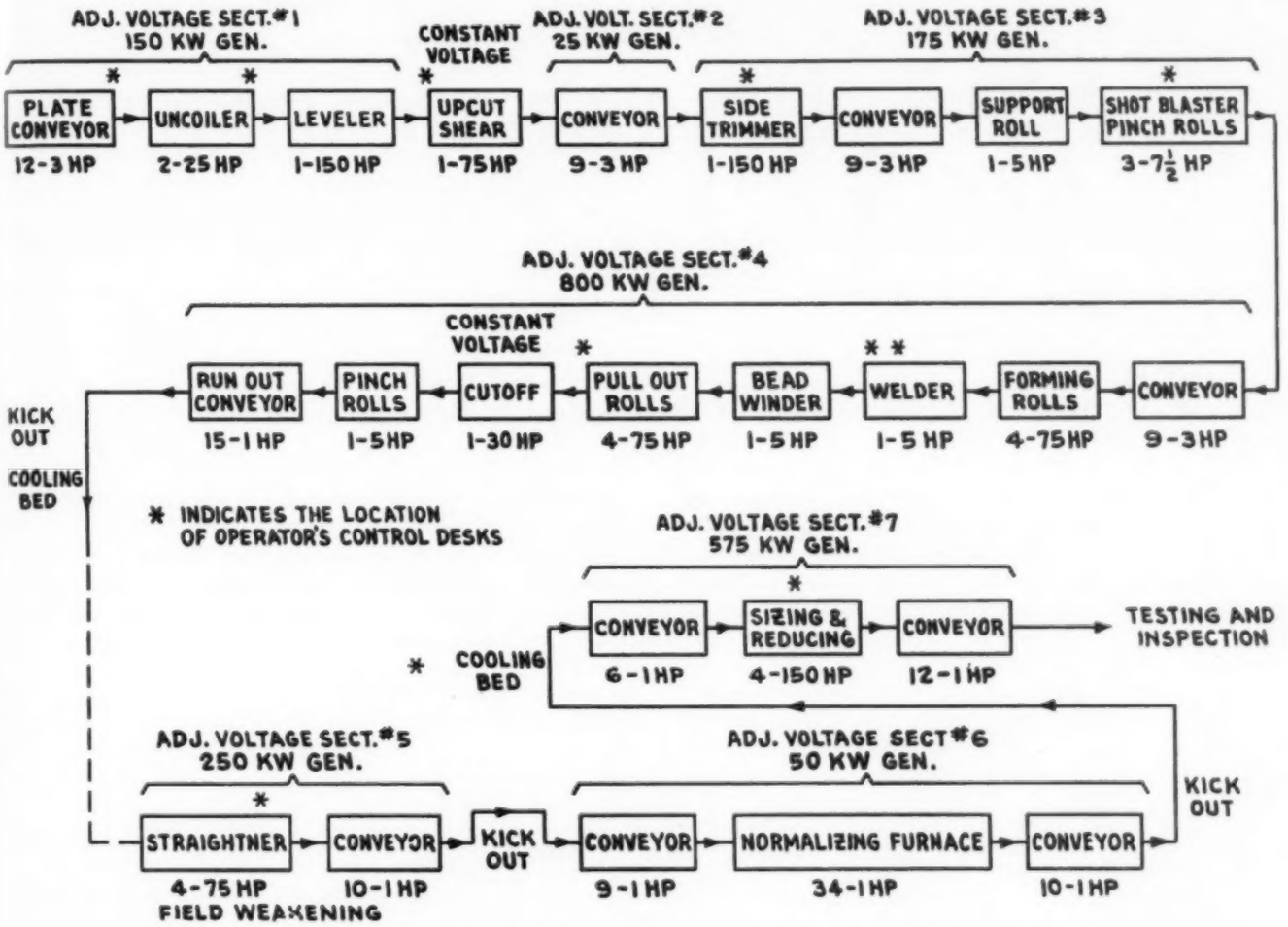

Figure 1 — Diagram showing sectionalization of adjustable voltage d-c drives.

from the weld wheel. Three pullout stands after the welder give an initial sizing operation to the pipe.

After the welding operation, the pipe is cut to length by a flying pipe cut-off machine and given a second sizing and preliminary straightening operation on a three-stand sizing mill. The pipe is then passed through a 240-ft long normalizing furnace. After cooling, the pipe is passed through a final reducing and sizing mill.

The operations described above require the use of 165 a-c motors totaling 8200-hp which range in size from ⅙-hp to 4500-hp as well as 168 d-c motors totaling 2500-hp and ranging in size from 1-hp to 150-hp. Also required are 7 d-c generators totaling 2100-kw for supplying the adjustable voltage motors. Five d-c exciters furnish control power for the d-c drives as well as field excitation for the synchronous motors which drive the large d-c generators. The weld power alternator is a 4000-kva, 2400-v, single-phase, 84-cycle machine which is excited from a 40-kw rotating regulator.

cutoff motor, have no definite speed relationship with the welding speed and, therefore, are excited from a constant voltage source. Although the weld speed range is from 40 to 120 fpm, the adjustable voltage controllers provide an adjustable speed range of 20 to 120 fpm with a jog speed range of from 20 to 40 fpm for thread-up operations. Speed control is obtained by armature voltage control of the drive motors. With one exception, the only shunt field weakening speed control provided for the drive motors is a vernier resistor in each field circuit for speed trimming. A vernier rheostat for trimming each of the larger motors is located on the appropriate control desk. In order to provide a continuous flow of pipe to the normalizing furnace, the straightener section must run at speeds from 40 to 250 fpm. The straightener speed range above 120 fpm is obtained by field weakening.

The mill drive motors, from the plate conveyor at the entry end of the mill to the flying cutoff machine

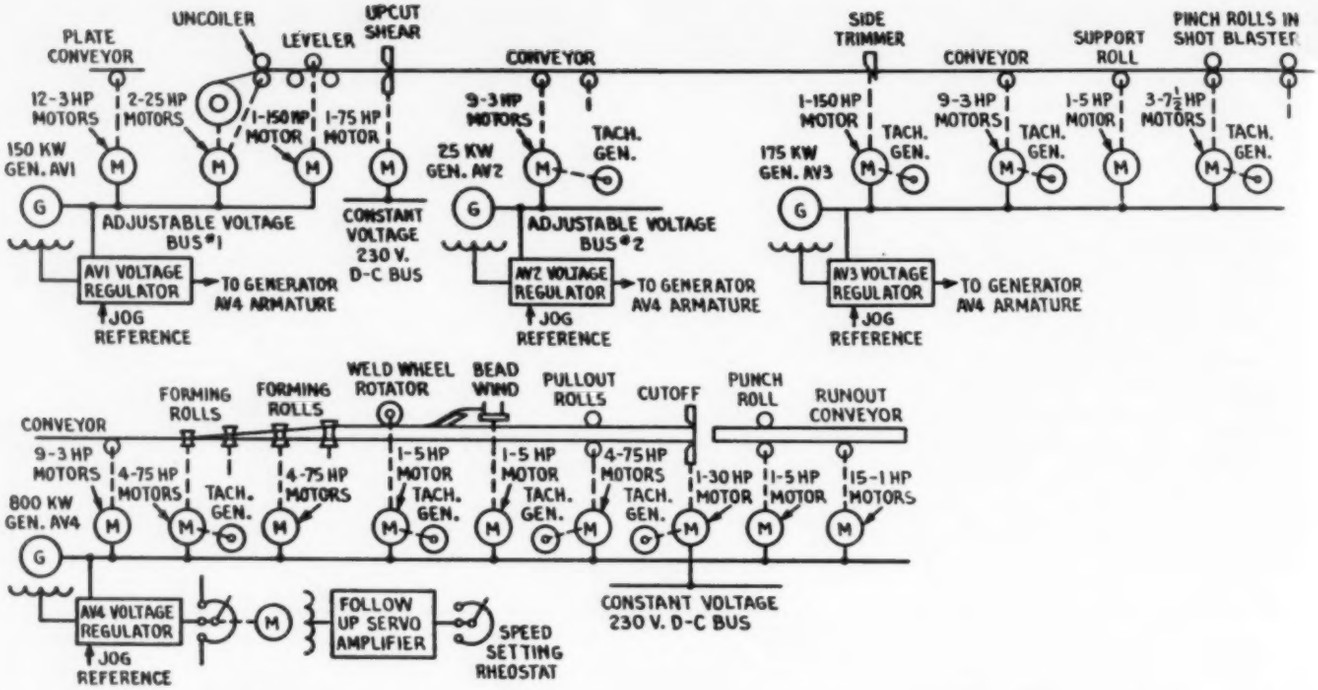

Figure 2 — Simplified one-line diagram of the four adjustable voltage drive motor sections between the entry end of the mill and the runout conveyor.

after the welder, are divided into four groups with each group being supplied from a separate generator (see Figure 2). The three generators nearest the entry end of the mill (generators AV1, AV2 and AV3) are tied to the weld section generator (AV4) by voltage regulator so that the four generators act as one large machine. The desired weld speed, which depends on the capacity of the weld power source and the thickness of the skelp, is obtained by manually setting the voltage of the weld section generator. The three entry end generators automatically follow the weld section generator due to the action of the voltage matching regulators.

Automatic voltage matching of the first four generators was obtained by supplying power for each of the generator shunt fields from a magnetic amplifier, closed loop, voltage regulator (see Figure 3). The voltage regulator for the lead generator (generator AV4) is sensitive to the difference between the reference voltage, which is obtained from a constant voltage reference exciter, and the armature voltage of the generator.

The weld section speed is adjusted by means of a small pilot rheostat on the welder control desk. A motor operated rheostat on the control panel (see Figure 4) automatically rotates to a position of the pilot rheostat through the use of a small magnetic amplifier servo

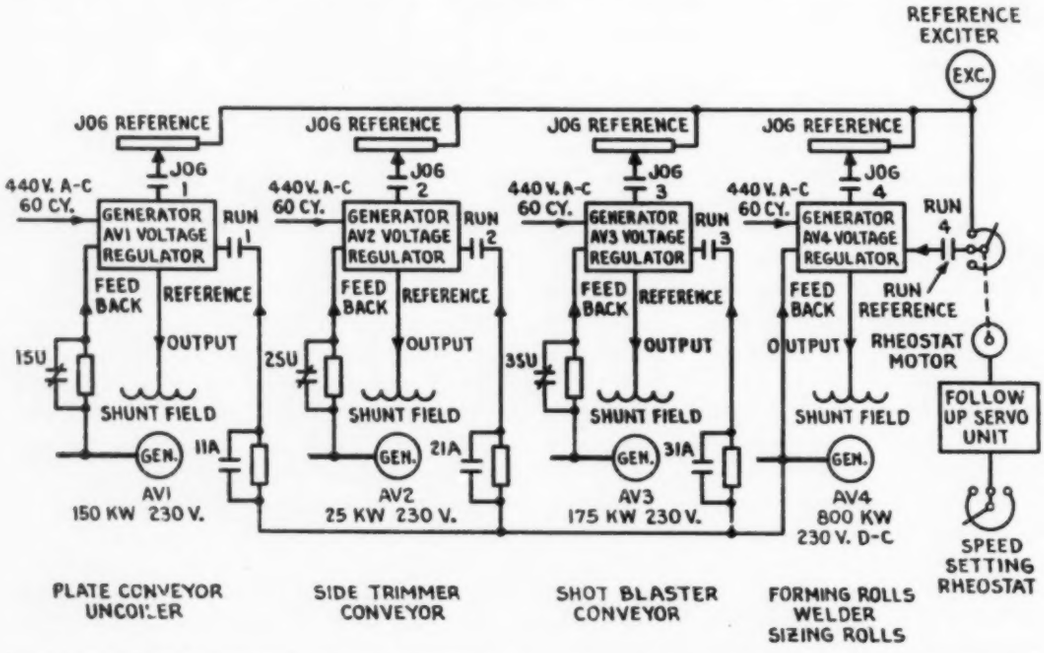

Figure 3 — Simplified block diagram of generator voltage regulator connections for first four sections of adjustable voltage d-c drive.

controller. The motor operated rheostat adjusts the reference voltage to the generator voltage regulator. The regulator reference voltage level determines the output voltage of generator and, thus, determines the speed of the weld section drive motors.

The motor operated rheostat, which controls the weld section generator voltage, is connected so that it always returns to the minimum generator voltage end of travel when the weld section is stopped and rotates to the preset position of the pilot rheostat whenever the weld section is started. This scheme uses the motor operated rheostat travel time, as a means of controlling the acceleration of the section motors. Acceleration is practically stepless and the acceleration time varies directly with the preset speed setting.

The reference voltage for the generator voltage regulators on the three entry end generators is obtained from the armature circuit of the weld section generator (generator AV4), see Figure 3. It is therefore impossible to run the first three generator sections at preset line speed until the weld section generator is energized. Any change in generator AV4 terminal voltage and consequently a change in speed of the section motors, is automatically signaled to the entry end generators through the voltage regulators. The voltage regulators immediately adjust the terminal voltage of generators AV1, AV2, and AV3 to correspond with that of the weld section generator AV4. This master-slave arrangement allows all the speed changing operations, such as acceleration, deceleration and line speed adjustments, to be performed on the weld section generator since the entry end generators will follow automatically.

The voltage regulators on the four entry end generators (generator AV1, AV2, AV3 and AV4) were designed so that IR drop compensation could be added, but this feature was found to be unnecessary. The speed matching problem between the four entry end generators is most important when pipe is being welded from coiled skelp since the sections are coupled mechanically by the skelp. However, for any given skelp size, the torque required from the mill drive motors is very nearly constant. Due to the very narrow torque range incurred, the generator terminal voltage regulators, which have an accuracy of 1 per cent from no load to full load at rated generator voltage, have given very satisfactory results.

A separately adjustable jog reference voltage is provided to the voltage regulator on each entry end generator. The jogging speed is adjustable from 20 to 40 fpm in either the forward or reverse direction for thread-up operations. Selector switches are provided on each of the four section control desks which connect the control circuits for either "group" or "individual" operation of the drive motor sections. If the master on the weld section control desk is set up for coiled skelp operation and each section selector switch is set for "group" operation, the four drive motor sections can be jogged as a unit from the weld section control desk. Individual section jogging is obtained by setting the section selector switch on "individual" and manipulating the jog button provided on the section control desks. Jog and emergency stop buttons are mounted at frequent intervals along the base of the mill as a safety

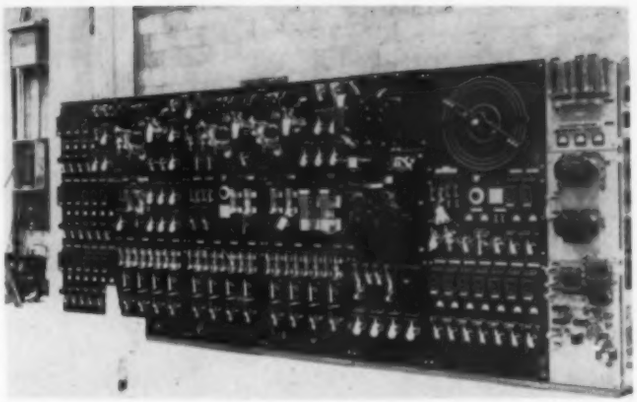

Figure 4 — The welder section adjustable voltage control panel is shown during the installation of the pipe mill.

precaution as well as to provide control stations which can be reached with ease during the thread-up operation.

When the control is set up to weld pipe from coiled skelp, all the emergency stop buttons are connected in series so that when any section is stopped all sections must stop. Starting of the mill can only be initiated from the weld section control desk and cannot be accomplished unless the selector switches on all section control desks are set for group operation. Since the entire mill from the entry end to the cutoff machine is threaded with skelp and welded pipe, these features are necessary to prevent cobbles or attempting to overhaul unenergized sections. Indicating lights on the master weld section control desk notify the weld operator when all sections are prepared to start. A system of signal horns and telephones also aid the operators to coordinate the start up procedure.

The speed matching problem is less important when pipe is being welded from precut plates of skelp, since all the mill drive motor groups cannot be coupled mechanically by the skelp at one time. When the master switch on the weld control desk is set for precut skelp operations, the control connections are arranged so that one section of drive motors can be stopped without disturbing the sections toward the exit end of the welding machine. However, in order to prevent a pile-up of skelp at the point of trouble, all motor sections toward the entry end of the line are automatically stopped. When the down section is started again, all the sections toward the entry end are automatically accelerated to preset line speed in timed steps. A speed boost feature is provided which allows the operator of any section to run his section and all sections toward the entry end of the mill at 125 per cent of preset line speed. Thus, any gaps in the flow of precut skelp to the weld wheel can be closed, providing a continuous flow of material to the welder.

The rotary cutting head for the cutoff machine after the welder is driven by a constant voltage 30-hp, d-c motor. The speed of this motor, which depends on the size of pipe being welded, is adjustable from the cutoff control desk. The carriage travel, chuck clamps, and cutting tool travel motions are all hydraulically driven and are controlled by limit switches and a-c solenoid valves. The cutoff control is arranged for three types of operation. If a master switch on the cutoff control

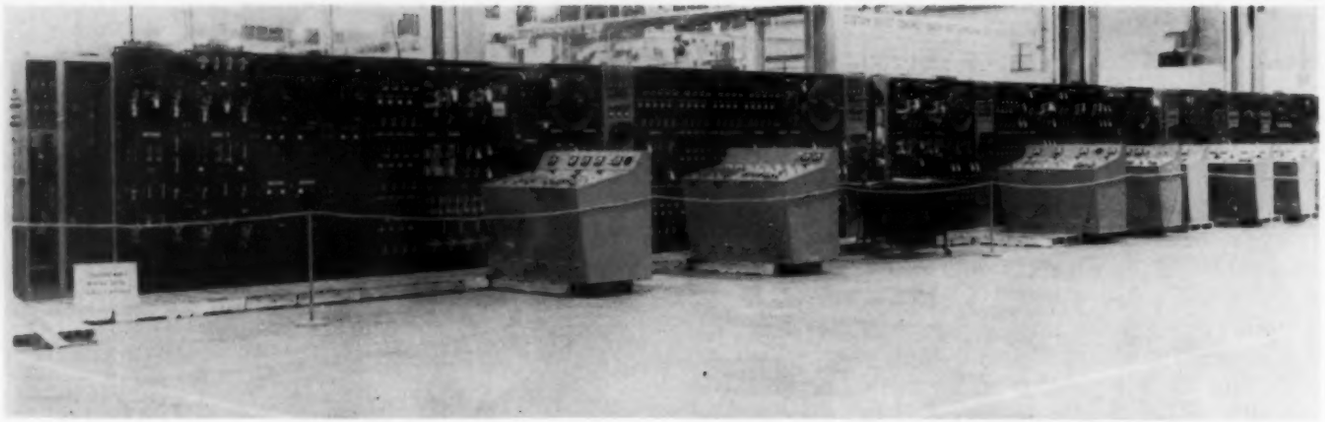

Figure 5 — The adjustable voltage control panels and control desks are shown on factory test floor before shipment.

desk is set for manual operation, the operator manipulates the individual cutoff motions manually by push-button control. With the master switch set for test operation, one complete cutoff cycle is obtained each time a test button is pressed. With the master switch set up for automatic operation, the cutoff sequence is automatically initiated when the leading end of the pipe strikes one of four flag switches. The flag switches are spaced for cutting pipe lengths of 15, 30, 45 or 60 feet, the desired length being selected by means of a selector switch on the cutoff control desk. A warning bell signals the operator when there is less than two cuts left in the remaining pipe stock so that he may determine how the last cut should be made.

After the cutoff operation the pipe is transferred to a chain driven cooling table by means of a rotary type kick-off and is delivered to the initial straightening machine.

The straightener, normalizing furnace, and reducing mill sections of the pipe mill are all adjustable voltage drives with each section being supplied by a separate generator. These sections handle precut lengths of pipe and are separated by long conveyors and cooling beds which allow for independent adjustment of the section speeds. However, in order to obtain a continuous flow of pipe without frequent adjustments of motor speeds, a magnetic amplifier voltage regulator is provided for each section generator. These voltage regulators are very similar to the one supplied for the welding machine generators. The main difference being that there is no attempt to provide automatic speed matching between the last three sections. A small pilot rheostat on each section control desk remotely controls the rotation of a motor operated rheostat by means of a magnetic amplifier servo controller. The motor operated rheostat controls the reference voltage to the voltage regulator and provides the time delay needed for smooth acceleration of the motors.

As mentioned previously, the straightener drive is the only adjustable voltage section on which motor shunt field weakening is employed in addition to armature voltage control. It is necessary for the straightener to run over a speed range of from 40 to 250 fpm and be jogged at speeds of from 20 to 40 fpm. The additional speed range above top welding speed is required to keep a continuous flow of pipe to the normalizing furnaces and prevent a pile-up of pipe on the cooling table after the cutoff machine.

On circuits involving several safety relays, fault finders have been included to assist in locating open circuits. Since the control circuit is very extensive, several fused control knife switches are provided, all connected in series, to aid in isolating any circuit grounds.

Eleven operator's control desks containing the push-buttons, master switches, meters and rheostat necessary for the operation of the pipe mill are located at strategic points. The location of the control desk is marked with an asterisk on Figure 1.

Figure 4 shows the control panel for adjustable voltage section AV4. This controller is mounted on a welded angle iron, Nema Class "AA", box type frame and is 90 inches high. Grid boxes and resistor units are mounted on the rear of the frame near the wall. Control and main terminal blocks are mounted behind the slate panel near the bottom of the frame. The motor operated rheostat for setting line speed is near the right side of the panel, while the components for the magnetic amplifier voltage regulator are mounted on the steel panel section on the right hand side. The adjustable voltage portion of the controllers for this pipe welding machine is 87 feet long. Figure 5 shows a portion of adjustable voltage controller before it was shipped to the Lone Star Steel Co. The section control desks are shown placed immediately in front of the controller section to which they connect.

WELD POWER CONTROLLER

The welding power delivered to the weld wheel electrodes is obtained from a 4000-kva, single-phase, 2400-volt, 84-cycle alternator which is driven by a 4500-hp, 13.2-kv, 60-cycle synchronous motor. The weld alternator field is supplied from a 40-kw rotating regulator. (See Figure 6 for a simplified diagram of the weld power circuit.) Three pairs of ignitron tubes, each pair connected in inverse parallel, act as weld contactors. The ignitron contactor load circuit is connected to three single phase 1330-kva, 2400/120-volt transformers with primary windings connected in parallel and secondary windings connected in series. The secondary circuit of the transformer bank is connected directly to the slip rings in the primary circuit of the weld transformer which is an integral part of the welder. The weld transformer revolves with the weld wheel electrodes and is

water cooled. The secondary winding of the weld transformer is connected to the weld wheel electrodes and is capable of delivering 275,000 amperes.

Ignitron contactors are used to interrupt the weld current in order to keep the amount of waste pipe to a minimum. No voltage must appear across the weld wheel electrodes as the leading edge of the pipe enters the wheel or when the trailing edge leaves the wheel since the arcing that would occur would burn and pit the weld wheel electrodes. The weld power must be applied very quickly after the initial contact between the weld electrodes and the pipe in order to keep the waste pipe to a minimum. Likewise, normal weld heat must be maintained to a point as near the trailing end of the pipe as possible before it is interrupted and it

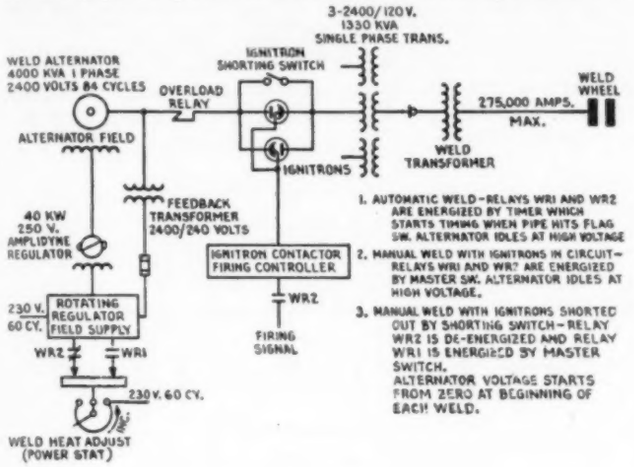

Figure 6 — Simplified diagram shows weld power circuit.

must be removed before contact is broken between the weld wheel and the pipe in order to prevent arcing. The instantaneous operation as well as the voltage and current ratings of the ignitron contactors make them ideal for this application.

During normal automatic welding operations, the weld alternator voltage is allowed to idle at a voltage somewhat higher than the normal weld voltage. Figure 7 shows the saturation curve for the weld alternator. Assuming that the desired full load weld alternator voltage is 2400 volts corresponding to point B, the alternator is idled at a voltage corresponding to point A. When the ignitron contactors are fired, the reference voltage to the alternator voltage regulator is switched to the value corresponding to 2400 volts output from the alternator. Thus, the alternator field current is not required to change when the weld load is applied and the alternator voltage decreases very rapidly from point A to point B. This arrangement tends to by-pass the response time of the alternator voltage regulator, since the alternator field current is not required to change when the load is applied. If the weld alternator were allowed to idle at 2400 volts when the desired full load voltage is 2400 volts, the alternator field current would be forced to change from point C to point B. Since the alternator field time constant is relatively long, considerable pipe would be wasted before the weld heat was stabilized.

A flag switch is used to initiate the application and removal of weld power. For mechanical reasons it was necessary to mount the flag switch approximately 5 feet in front of the weld wheel. The application of weld power must be delayed for the period of time corresponding to 5 feet of pipe travel at any line speed and this time delay must accurately repeat in order to prevent the application of weld power before the pipe contacts the weld wheel electrodes. In order to keep pipe waste below 6 inches on each end, the weld power must be applied and stabilized in 0.25 seconds or less after the pipe has contacted the weld wheel electrodes if the welding speed is 120 fpm. A special electronic timer was designed for this application which has a maximum repetitive time error of 2 per cent of the set time over its entire range of 2.5 seconds to 25 seconds, and which is insensitive to line voltage fluctuations. This allows ample time for stabilization of the weld heat after application of power without wasting more than 6 inches of pipe. Two electronic timers are used; one for the application of weld power after the flag switch is tripped and one for the removal of weld power after the flag switch is reset. A rheostat for adjusting the delay time corresponding to line speed is provided on the weld control desk.

Three shorting switches are mounted on the weld power controller which are used to short out each pair of ignitrons when welding pipe from coiled skelp or in case of failure in the weld contactor circuits. When

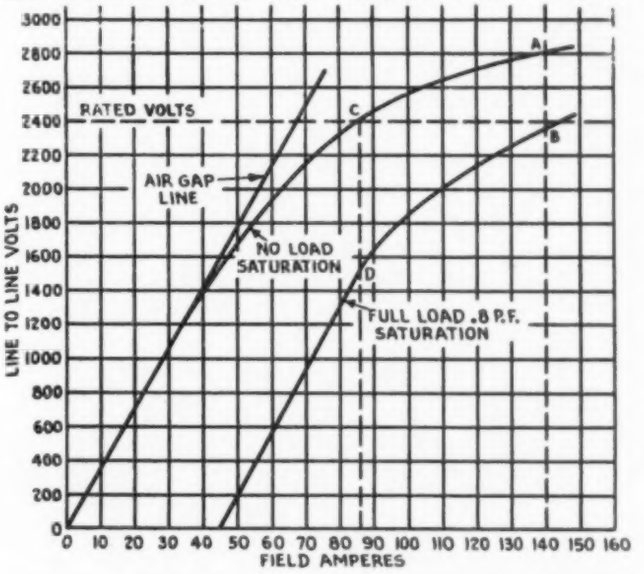

Figure 7 — Saturation curve for weld alternator 4000-kva, 2400-volts, 0.8 power factor, single-phase, 84-cycle, 1667 amp full load.

welding from coiled skelp, the length of waste pipe which appears at each end of the coil can be greater than the waste at the ends of precut plates of skelp since weld power is applied and removed only once for each coil. There may be several hundred feet of skelp in each coil while the precut skelp consists of plates 30 feet long. While welding with the ignitron contactors shorted out, it is necessary to drive the weld alternator voltage up and down by alternator field control since there is no disconnecting means available in the alternator output circuit. Due to the relatively long response time of the alternator field circuit, this method of controlling weld power involves more waste pipe than does the use of the ignitron contactors. However,

the fact that the life of the ignitrons can be greatly prolonged by use of the shorting switches, when welding coiled skelp, overshadows the increased amount of waste pipe.

Weld power can be controlled manually by use of a master switch on the weld control desk as well as automatically from the flag switch. The ignitrons can be shorted out for either manual or automatic weld heat control.

A-C CONTROLLER

The a-c portion of the pipe mill controller consists of across-the-line starters for the motor-generator set motors, hydraulic pump motors, pipe conveyors and screwdown motors. Relay panels for the automatic cut-off sequence, pipe manipulators and kick-off machines are provided as well as the main generator heater contactors.

A bearing overtemperature system warns the operators in case of overheating of the bearings on the five large motor-generator sets or the windings of the three single-phase high tension weld transformers. A set of indicating lights on the controller indicates which bearing is overheated. A klaxon horn is energized at the same time and can be turned off by the operator after the location of the trouble has been determined. The indicating light remains on as long as the overheated condition exists. No provision is made to stop the mill automatically since the welder and the normalizing furnaces should be cleared of pipe before stopping. However, once the motor-generator set drive motor which is overheated has been stopped, it cannot be restarted until the bearing cools. Contacts are provided on the bearing temperature controller for operating a target drop annunciator.

The above a-c control equipment as well as the feeder circuit breakers has the same construction as shown in Figure 8. A total of 100 feet of this 90-in. high construction was required for the tube welding mill.

Although there are two or three other continuous resistance welding tube mills in existance today which are comparable in size to the one at Lone Star Steel Co., it is felt that the controller for this mill offers a flexibility of operation which had not been attained before. This mill is the first one designed for continuously welding casing from multiple width skelp which may be either coiled or precut into plates.

Figure 8 — Typical a-c controller section.

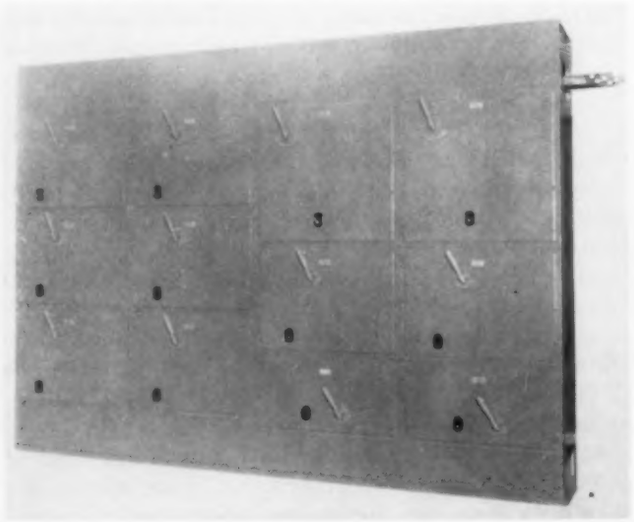

Figure 9 — The tube mill controllers are located along the right hand wall and motor-generator sets are in the center of the room in the background.

DISCUSSION

PRESENTED BY

P. S. JOHRDE, Section Engineer, A-C Generator Section, Elliott Co., Ridgway, Pa.

P. S. Johrde: The author has given an excellent account of the control applications on a large resistance-welding tube mill. The most recent designs have been incorporated in this mill to make it quite outstanding compared to similar mills already in service elsewhere.

His paper also gives a good general description of the mill and its associated components, some of which are unique in themselves. The welding power generator, on the right in Figure 10, (rated 4,000-kva, single-phase, 2400-volt, 84-cycle) is the most powerful single

Figure 10 — The welding power generator is rated at 4000-kva, single phase, 2400-volt, 84-cycle.

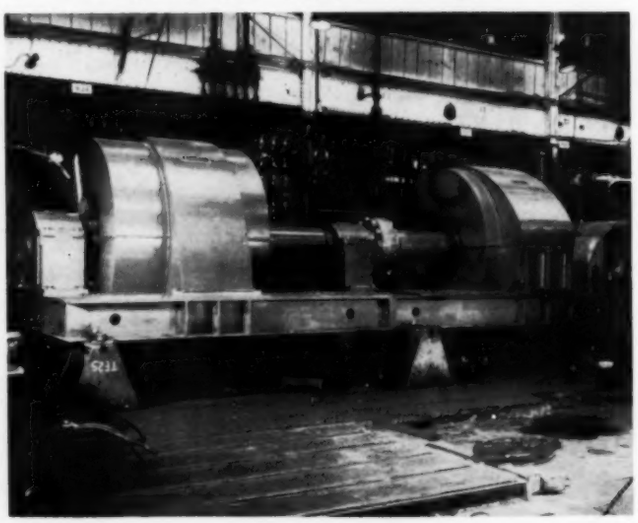

Figure 11 — Pedestals supporting the frame are located level with the shaft.

Figure 12 — Stator is mounted on rubber shockmounts.

unit to be applied to resistance-welding of tubing. Several special features were incorporated in the design of this generator and a discussion of these features is given below to supplement Mr. Smith's paper.

The stator winding is insulated with 3500-volt insulation instead of 2400, to assure normal coil life with the generator feeding power through the ignitron contactor at 2400 to 2800 volts continuously.

The short-circuit ratio of the generator is much higher than normal to provide good voltage regulation. This holds the change in voltage from full-load to no-load to a practical minimum when the ignitron contactor is in operation.

A very low resistance field winding was placed on this generator to reduce the voltage across the collector rings to 145 volts when rated load was being generated. This extended the field forcing effect of the 250-volt rotating regulator considerably.

Although the generator operates single-phase, it has a normal wye-connected, three-phase winding with three leads brought out. Rated single-phase load can be carried across any two of the three leads. This construction provides: (1) uniform bracing of coils, (2) identical coils throughout the winding, (3) connections between coils which are familiar to most electricians, (4) a spare phase (one-third of the coils) which can be used either as a unit or robbed of coils for repair in case of failure in either of the other two phases.

Figure 10 shows both the motor and generator shafts with extensions toward the center bearing. This construction allows either stator to be shifted toward center so stator or rotor coils can be replaced without disturbing the rotor alignment.

This same illustration shows a pedestal between the base and the generator frame; note that the frame feet are at the same level as the shaft. Figure 11 is a close-up view of one of the two pedestals supporting the frame. It was necessary to locate the frame feet level with the shaft, because the stator is mounted on rubber shockmounts which lie between the frame feet and the top of each pedestal; and horizontal components of forces resisting torque must be prevented from acting on these shockmounts. Figure 12 shows the shockmounts in place after the cover plate is removed.

The large set screw and adjacent parts on the side of the pedestal comprise one of the four snubbers which restrain the rotary motion of the stator in case of short circuit. These are necessary since the strength of the shock-mounts is not as great in tension as in compression. There is clearance between the set screw and the large pin during normal operation. The shock-mount shown in Figure 13 is similar to the ones used on this machine. The upper part is an inverted steel channel to which the stator is bolted. This channel is bonded to a steel base plate by thick rubber. The base plate is bolted to the pedestal.

Shock-mounting a generator of this type reduces the amount of double frequency, i.e., 168 cps, vibration which can be transmitted to the foundation and it smooths out the shock caused by the sudden loading and unloading through the ignitron contactor. The latter condition is peculiar to this installation but the double frequency vibration is a characteristic of all single-phase synchronous generators.

Figure 13 — The shockmount consists of an inverted steel channel to which the stator is bolted.

Rubber shock-mounting of large, rotating electrical machines has been used several times by our company, but this is the first application to an industrial machine. It may be the first large single-phase generator to be shock-mounted on something other than steel springs.

HIGH ALLOY CASTINGS REDUCE STEEL PLANT MAINTENANCE

▲ INCREASED use of high alloy castings is accelerating the steel industry's program of expansion and modernization. Cast high alloy materials that successfully meet the requirements of the engineer for use in a wide variety of temperature conditions, are shown in the accompanying chart of typical composition ranges (Table I). In line with the designations of the Alloy Casting Institute, technical association of high alloy foundries, each of these alloy designations is prefixed with the letter "H" to denote that it is part of the heat-resistant series. A comparable series of cast materials for corrosion resistant applications is available.

To obtain the increased life necessary for economical and efficient operation, steel industry engineers are taking advantage of the properties of these cast chromium-nickel alloys. In heating sheet and plate, for example, the design of continuous heating furnaces would be impossible unless the engineer had at his disposal materials that could withstand high temperatures and temperature cycling, and resist the corrosive effects of gaseous products for long periods of time. Almost any combination of temperature and atmosphere conditions can be satisfied through the choice of a proper alloy combined with proper design. The following descriptions of individual applications will illustrate in detail how cast high alloys are meeting the new demands of the steel industry.

SOAKING PITS AND REHEATING FURNACES

One of the most important phases of steel production takes place in soaking pits (Figure 1) or reheating furnaces.

Pit covers—Ingots are placed in the soaking pit in an upright position through an opening in the top. A removable cover which raises vertically before traversing closes the pit opening. The modern soaking pit cover is constructed of a heavy steel frame which supports a suspended arch of high grade firebrick. The steel frame is protected on its under side by a cast high alloy angle type seal provided with a lip that penetrates into the sand seal. The sand seal, located on the periphery of the top of the pit, is a gutter-shaped space filled with sand. It is very important for this high alloy angle type seal to effect a perfect closure as it would not otherwise be possible to maintain the required furnace pressure necessary for correct furnace performance.

TABLE I

Standard Designations and Chemical Composition Ranges for Heat Resistant Castings

Cast alloy designation	Wrought alloy type (See Note A)	Composition — per cent							
		C	Mn max	Si max	P max	S max	Cr	Ni	Other elements
HC	446	0.50 max	1.00	2.00	0.04	0.04	26-30	4 max	Mo 0.5 max*
HD	327	0.50 max	1.50	2.00	0.04	0.04	26-30	4- 7	Mo 0.5 max*
HE	.....	0.20-0.50	2.00	2.00	0.04	0.04	26-30	8-11	Mo 0.5 max*
HF	302B	0.20-0.40	2.00	2.00	0.04	0.04	18-23	8-12	Mo 0.5 max*
HH	309	0.20-0.50	2.00	2.00	0.04	0.04	24-28	11-14	Mo 0.5 max* N 0.2 max
HI	.....	0.20-0.50	2.00	2.00	0.04	0.04	26-30	14-18	Mo 0.5 max*
HK	310	0.20-0.60	2.00	3.00	0.04	0.04	24-28	18-22	Mo 0.5 max*
HL	.....	0.20-0.60	2.00	3.00	0.04	0.04	28-32	18-22	Mo 0.5 max*
HT	330	0.35-0.75	2.00	2.50	0.04	0.04	13-17	33-37	Mo 0.5 max*
HU	.....	0.35-0.75	2.00	2.50	0.04	0.04	17-21	37-41	Mo 0.5 max*
HW	.....	0.35-0.75	2.00	2.50	0.04	0.04	10-14	58-62	Mo 0.5 max*
HX	.....	0.35-0.75	2.00	2.50	0.04	0.04	15-19	64-68	Mo 0.5 max*

*Molybdenum not intentionally added.

NOTE A — Wrought alloy type numbers are listed only for the convenience of those who want to determine corresponding wrought and cast grades. Because the cast alloy chemical composition ranges are not the same as the wrought composition ranges, buyers should use cast alloy designations for proper identification of castings.

NOTE B — Most of the standard grades listed are covered by American Society for Testing Materials specifications A 296-49T and A 297-49T.

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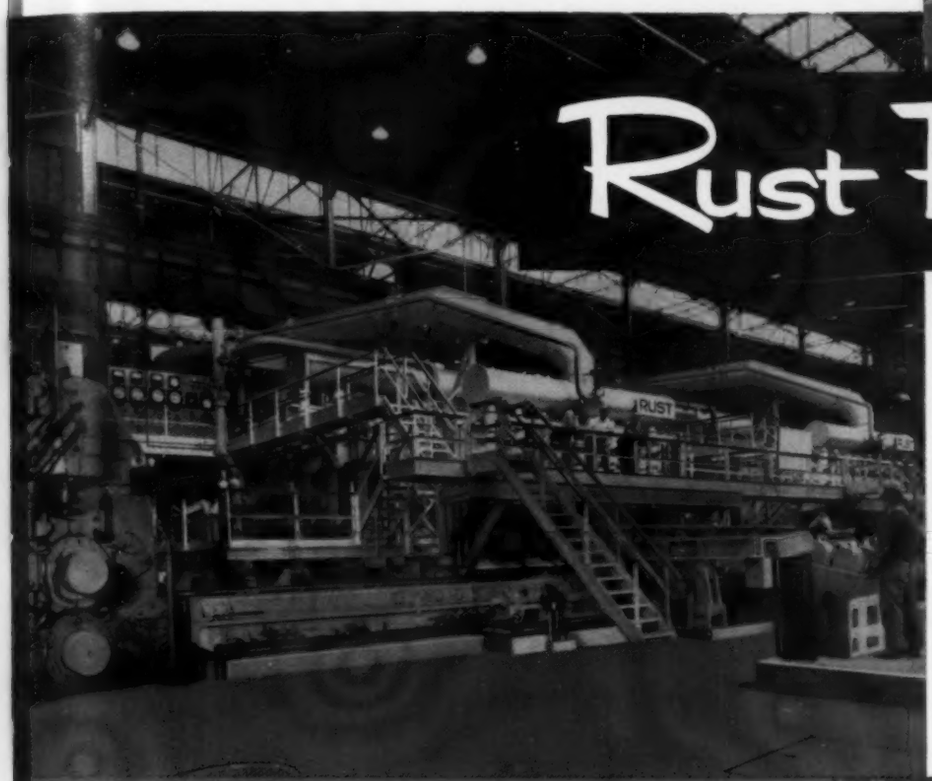

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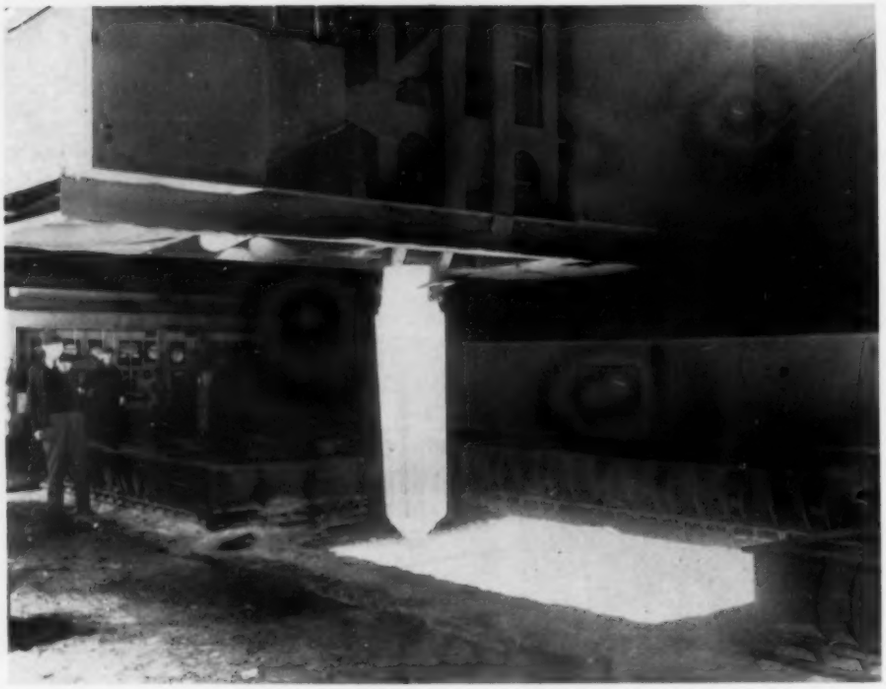


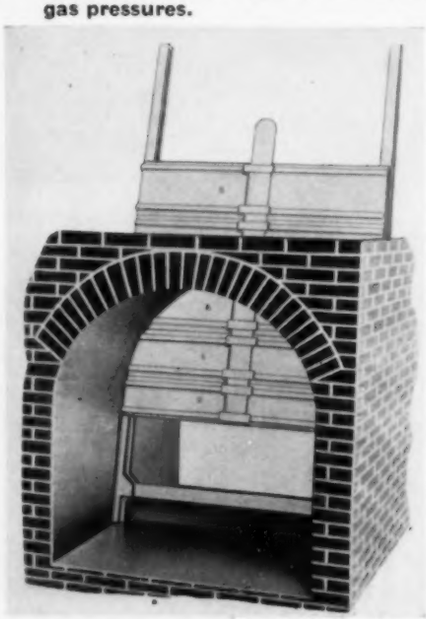
Figure 1 — Use of type HH cast alloy seals on pit covers, replacing cast iron, extended average service life from three weeks to one year, and resulted in a 70 per cent weight reduction. (The Timken Roller Bearing Co.)

Manufacturers of soaking pits, such as the Amsler Morton Corp. of Pittsburgh, Pa., utilize an angle type seal cast of the HH grade alloy (Figure 2). Containing 24 to 28 per cent chromium and 11 to 14 per cent nickel, this type has high strength, ductility and corrosion resistance at temperatures of 2000 F. The HH grade can be produced as partially ferritic or wholly austenitic; the ferritic type providing higher hot ductility and the austenitic higher hot strength. The particular HH composition chosen depends on the temperature of operation of the soaking pit—the temperature to which the soaking pit cover is exposed.

Figure 2 — Seal castings, made of type HH alloy form the rim around the bottom of soaking pit covers. These must withstand the heat radiated from the pits.

Furnace dampers — The application of high alloy castings to furnace dampers (Figure 3) is another example of using modern materials to achieve the new goal of efficiency set for itself by the steel-making industry. It is necessary to have an alloy that will not only resist the high temperatures, but will also withstand the corrosive elements in the gas. A special additional problem is the actual gas pressure, which has a tendency to "bow" the materials used in the damper.

Figure 3 — Sectional furnace dampers assembled from type HH alloy castings resist temperatures as high as 1900 F, corrosive gases, and high gas pressures.



After failures with less hardy materials, type HH alloy was chosen for this application. As applied by steel companies, such as Newport Steel Corp., Newport, Ky., and West Virginia Steel Manufacturing Co., Huntington, W. Va., the dampers are installed at some point in the flue between the furnace and the stack; they are always operated in the vertical position.

A special design for these stack dampers involves sectional construction to avoid failure due to abrasion which acts on the bottom section of the damper. The sectional damper design permits uniform independent expansion in each section. Another advantage is that sections can be made from the material best suited for the particular furnace atmospheres and temperatures. Using this type of construction, dampers have been installed to withstand temperature; from 900 to 1900 F. To minimize seepage, and thus better to control furnace pressure, the various sections—bottom, top and several intermediate parts—are mated by tongue and groove fit. The damper is raised and lowered in the vertical guides located at each side of the flue.

In addition to type HH alloy, other high alloy grades are used if special furnace conditions exist. For instance, if furnace gases are high in sulphur content types HD or HE alloys are used; this is because the lower-nickel grades have better resistance to the action of the sulphur-containing gases.

Skid rails—Conditions that exist in soaking pits also are present in billet reheating furnaces. The best fuel efficiency is obtained in continuous furnaces that are relatively long, have hearths fully covered with steel, and are operated at a continuous high rate. In many cases water-cooled skids are being replaced by cast skid rails made of HT alloy, thus eliminating water cooling.

Greatly increased life of furnace equipment can often be directly attributed to replacement of vital parts by high alloy castings. A good example of such replacement can be found in the slab reheating furnaces located in the Chicago plant of the Ingersoll Products Division, Borg-Warner Corp. In these furnaces, skid discharge rails cast of HT alloy have replaced rails made of medium manganese steel. The furnaces operate at

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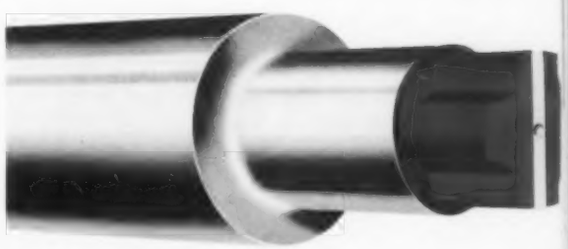

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about 2300 F, and temperatures at the rails themselves are about 1800 F. The redesign of the skids in the high alloy material thus effected an immediate weight saving of about 35 per cent. More important, however, is that the result of the change to the nickel-chromium alloy has more than doubled the life of the skids.

SHEET AND BAR ANNEALING

Annealing of cold-rolled sheet, strip, and bars is a vital step in the production of semi-finished steel products. Many annealing operations are performed in the steel industry by means of radiant tube furnaces. In annealing cold rolled strip and sheet, it is desirable to avoid surface corrosion by preventing the products of combustion from reaching the material being processed. This is achieved by passing the hot gases through radiant tubes which reach about 1650 F during the annealing treatment. For resistance to the products of gaseous combustion and the 1650 F temperature, HH type alloy frequently is chosen for the tubes.

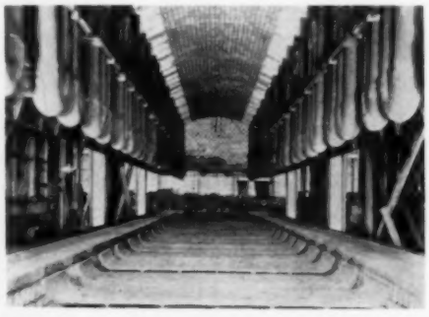

Figure 4 — Radiant tube furnace for annealing and carbon restoration of bar stock uses type HT alloy for radiant tubes and work supports.

The HH alloy is used in a wide variety of similar applications, including annealing retorts which are placed in hood type furnaces to anneal such products as tool steel. Here again, the products of combustion are kept away from the final product except that the product is on the inside of the alloy container, which, in turn, is surrounded by the gas. HH alloy is very useful where exposure to high sulphur content anthracite producer-gas is encountered.

Figure 4 shows a radiant tube furnace for the annealing and carbon restoration of bar stock. In this particular type of furnace, temperatures of 1800 F are not uncommon. Because of the slight carburizing atmosphere needed for carbon restoration, the alloy chosen for the radiant tube castings and the "buck" castings for support of the bar stock is the HH type.

The HT type alloy is particularly useful in carburizing and carbonitriding atmospheres. Containing 33 to 37 per cent nickel and 13 to 17 per cent chromium (including up to 1.25 per cent silicon for increased resistance to carburization), this type operates satisfactorily at temperatures up to 2100 F in oxidizing atmospheres and up to 2000 F in reducing atmospheres. As in all high nickel types, the alloy is fully austenitic and notable for excellent hot strength.

WIRE MILL APPLICATIONS

Equipment used in the annealing and tempering of wire illustrates again the ability of high alloy castings to give longer life than possible with conventional materials.

A case in point is the tempering operation at a large wire company. This process is carried out in a "lead-pan," in which the wire is drawn through molten lead, at temperatures of 1600 to 1650 F. For many years heavy-wall cast iron pans, with two- or three-inch section thicknesses, were used in this high temperature operation. Pans were therefore tremendously heavy and needed heavy furnace construction to support them. Failure of the cast iron pans, from the combination of rapid sealing and deformation due to low strength at high temperature, resulted in an average service life of only 22 to 30 operating days.

Frequent shutdowns resulting from pan failures involved labor of three to four men, on one eight-hour shift, to make the pan changes. Sometimes the cast iron pans were completely burned through, causing the lead to spill on the refractory arches, which would consequently burn out and break down. When this happened an additional 24 hours were required for cooling the furnace before working on it, another 24 hours for labor, and 16 hours to get the heat back up.

The change from cast to high alloy permitted a redesign of the pan (Figure 5), involving a considerable reduction in weight. As a result, the furnace construction did not need to be so heavy for support, and thinner wall sections permitted more rapid heating of the molten lead. Type HH alloy was prescribed by the foundry that supplied the castings to provide the needed combination of high temperature strength and corrosion resistance.

In the installation described, the high alloy pan was removed after 24 months of operation. Thus, the use of a high alloy casting not only increased efficiency of operation, but also reduced costly maintenance and lost time by providing better than 13 times the pan life previously obtained.

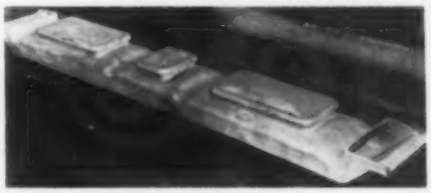

Figure 5 — Redesign of wire-annealing "lead pan" from cast iron to type HH alloy resulted in considerable weight reduction and extension of service life.

METALLIC RECUPERATORS

A very active trend in the use of high alloy castings is their application to recuperators for heat transfer in reheating furnaces and soaking pits. Higher gas pressures and higher gas volumes required by modern heating furnaces, coupled with increasing fuel costs, have made steel producers more aware of the advantages offered by metallic recuperators.

Metallic recuperators are reported to be less costly to maintain than ceramic recuperators, even in the case of continuous buttweld furnaces where operating conditions are more severe and hazardous than those encountered in heating furnace operation. About 125 steel heating furnaces are equipped with metallic recuperators in American steel industry, and the trend is toward replacement of refractory recuperators on older installations.

In a paper given at the 1953 annual meeting of the Association of Iron and Steel Engineers, at Pittsburgh, Pa., Mr. E. A. Vierow, Youngstown Sheet and Tube Company, pointed out that recent installations of metallic recuperators have shown effective heating capacity to be increased as much as 20 per cent, with fuel savings up to 30 per cent.

Figure 6 — Metallic recuperators, made from a variety of cast high alloys, allow considerable fuel savings in soaking pits and other furnace installations.

According to Mr. Vierow, the use of metallic recuperators in heating operations offers an excellent opportunity for the steel industry to make substantial savings in production costs.

These recuperators can be manufactured in a wide variety of cast heat resistant high alloys, depending upon conditions of the application. A typical recuperator design marketed by Thermal Transfer Corp., Pittsburgh, Pa., shown in Figure 6, is cast of type HD alloy. Containing 28 per cent chromium and 5 per cent nickel, type HD can be used where moderate stress is encountered up to 1400 F; and for somewhat lighter load bearing duties up to 2000 F. Because of its high chromium content, type HD resists oxidation and is useful in high sulphur containing atmospheres. Among other analyses frequently used in the manufacture of Thermal Transfer Corp. recuperators are: (a) type HB for applications where waste gas temperatures run up to about 1650 F; (b) type HC for applications where waste gas temperatures run up to about 1800 F. Both these grades are used for relatively low load applications. Where high loads are encountered, the higher nickel alloys such as types HH and HT are often used.

SELECTING AND HOUSING WORM GEARING

By JAMES E. GUTZWILLER
Assistant Chief Engineer
Standard Products Div.
De Laval Steam Turbine Co.
Trenton, N. J.

▲ WORM gearing, in addition to its widespread usage in the form of enclosed speed reducers, is employed as an integral part of machines of many types. One of the most unusual features of worm gearing is that the pitch diameters of the worm and gear are not proportional to the reduction ratio. A single compact set of gearing can provide a large reduction in speed, avoiding the need for a multiplicity of gearing members and bearings. Ratios between 3:1 and 100:1 are practical for power transmission and even higher ratios are employed for indexing and positioning devices.

Materials selected for the worm and gear are governed by the nature of the gear tooth contact. The meshing of the worm threads and gear teeth is a combination of sliding and rolling action with the sliding becoming dominant with the higher ratios. Because of this, dissimilar materials are normally selected for the two gearing members, with the worm, which experiences the larger number of contact cycles made of the harder material. The higher the rubbing velocity, the more critical is the need for materials which operate with good frictional or bearing properties.

The worm is usually made of steel and heat-treated after the worm threads are rough formed. Case hardening is the process most commonly used to obtain the surface hardness desirable for wear resistance. Many types of materials are used for the gears, but bronze predominates. For very slow speeds where bearing properties are not such an important factor, cast iron and hard bronzes, such as aluminum and manganese bronzes may be used. However, for general application over a wide range of speeds, experience indicates the best combination of materials is an alloy steel worm, case-hardened and thread ground, mating with a chill cast

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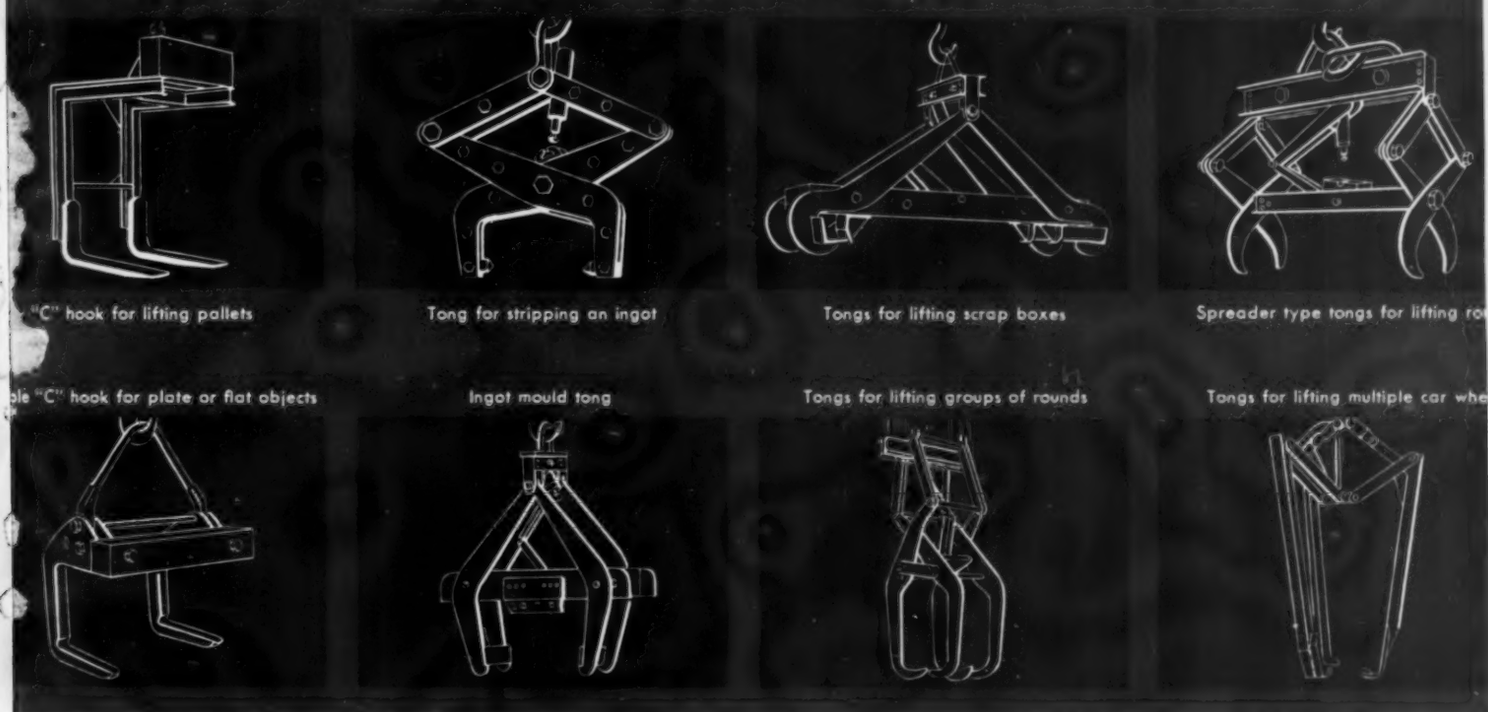
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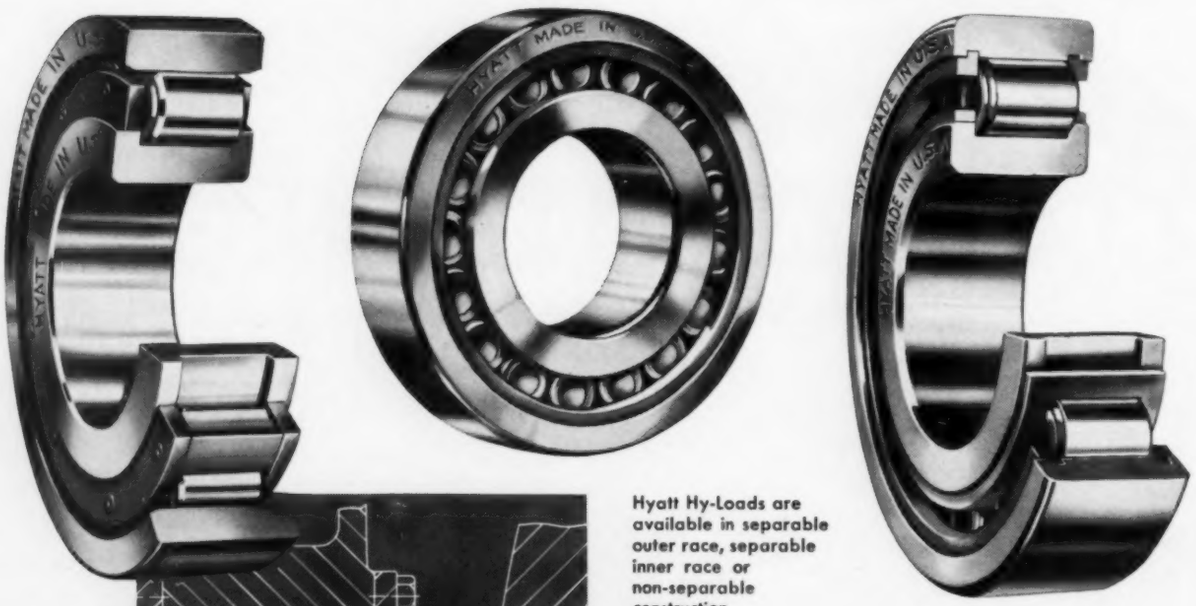

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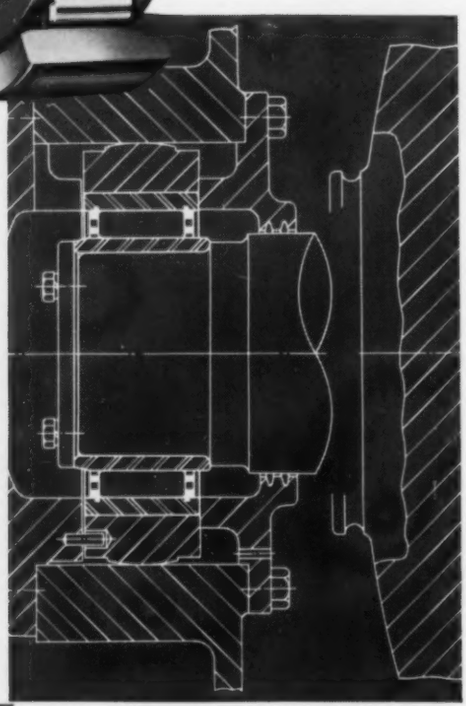

Check the drawing at the left. The bearing is a Hyatt Hy-Load, and because the inner race is cylindrical, the shaft it supports is free to move axially—thus allowing for shaft expansion without cramping the bearing or distorting the shaft. Obviously, this is only one of many ways in which Hyatt bearings can be used to reduce costs as they reduce friction, but it's a good example of why so many designers throughout industry keep their Hyatt catalogs within easy reach.

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nickel-tin-bronze gear. Most manufacturers of worm gear speed reducers employ gearing of this type as their standard.

Worms may be formed integrally with their shafts or bored and assembled on their shafts. The latter type is commonly known as a "shell worm." Practical limitations make the "shell worm" a necessity on some applications. For example, gearing used to drive oil pumps or governors from a turbine shaft normally incorporate "shell worms." The bore of this type of worm must be made of sufficient size to accommodate a shaft of the required stiffness, and as a consequence, the worm diameters are usually abnormally large in comparison to those for the integral type. Increased diameter results in a decreased lead angle and higher rubbing velocity which in turn account for lower efficiency and load carrying capacity. For these reasons the integral type worm is preferred.

The establishing of comparative power capacities for worms and gears of various material combinations has been slow in developing. Some data relating to this subject has been published, but this lacks sufficient verification by test and application to be of much value. Establishing of load carrying capacities for various grades of cast iron, for example, has been very difficult as these materials are not consistent in performance.

American Gear Manufacturers Association has established ratings for the class of gearing generally employed in worm gear speed reducers. These ratings (AGMA standard 213.02 Surface Durability of Cylindrical Worm Gearing) apply to gearing incorporating an alloy steel worm, case-hardened and thread ground, and a gear of chill cast nickel-tin-bronze. The determination of ratings for this type of gearing was practical in view of the many years of application on a large variety of applications.

This rating standard recognizes five distinct classifications of service based on the nature and duration of loading. The basic rating is intended for use under service conditions of 8 to 10 hours a day operation with no recurrent shock loads. Service factors, for either increasing or decreasing the basic ratings, are to be applied where service is in accordance with the other classifications. In all cases, momentary loads equal to 300

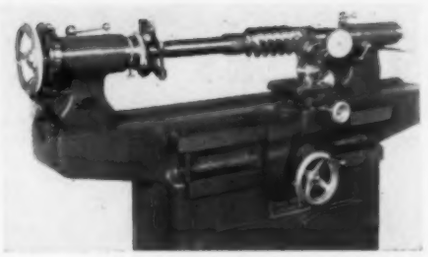


Figure 1 — Checking lead on worm is important.

per cent of the basic class 1 rating at 100 rpm are permitted.

The hob to be used for cutting the gear is one of the most important factors to be considered in designing a worm and gear, as the hob must be of essentially the same form as the worm. In order to avoid the expense and delays which go with the procuring of a special hob, it is wise to base the design of the worm on an existing hob. If the gearing is to be purchased, the supplier should be consulted prior to final design as tooling will normally be available for producing gearing which will meet the basic requirements.

Due to the special nature of machines and the "know-how" required for producing high quality worm gearing, the user of this type invariably purchases the gears from a company specializing in their manufacture. Most suppliers also produce a standard line of speed reducers and as a consequence, manufacture worms, gears, bearing housings and end covers in large quantities as stock parts for complete units. Consideration should be given to use of such standard components in order to effect savings in cost and to take advantage of their availability.

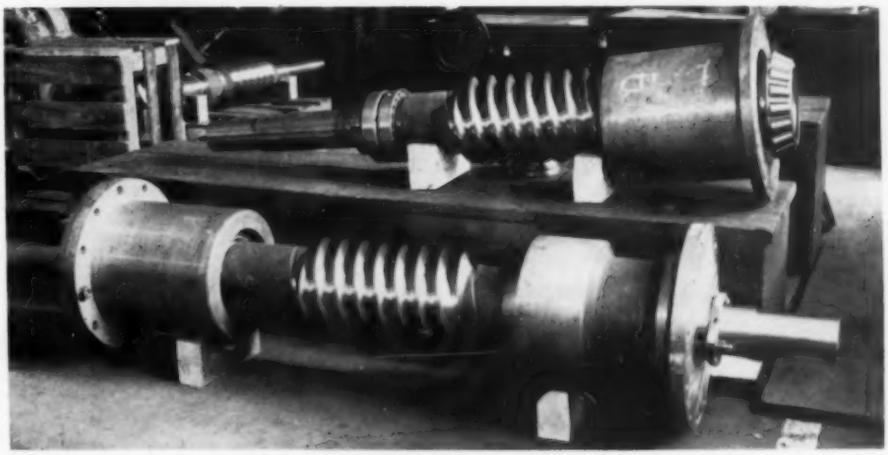
After preliminary selection of gearing has been made, thought must be given to its arrangement and support. In order to determine the requirements for bearings, the gearing forces must be calculated and resolved into bearing loads.

Final selection of bearings is affected by many factors, among which are: speed, combination of forces, arrangement of bearings, and ease of assembly. The worm is subjected to a large component of thrust which must be accommodated by an adequate thrust bearing. During the period after the start of operation when the temperatures of the lubricant, gearing and casing rise, expansion of the worm and casing may occur at different rates. This factor must be considered in selecting and supporting bearings to prevent excessive loading.

Angular contact ball bearings or tapered roller bearings may be used for short worm spans (up to eight or nine inches). Bearings at one end of the worm are designed for carrying combined radial and thrust loads and may consist of either a pair of duplex ball bearings or a pair of tapered roller bearings. The radial bearing may be either a ball bearing or cylindrical roller type arranged so endwise expansion of the worm can be accommodated. In the case of a ball bearing this may be accomplished by avoiding any restriction of the endwise movement of the bearing in the housing. Cylindrical roller bearings may be selected which permit this movement within the bearing itself.

Tapered roller bearings are most commonly used for the support of the gear shaft although almost all types are in use for this purpose. Con-

Figure 2 — Partially and completely assembled worm with housing class L, AGMA service, is rated at 201 hp at 410 rpm. These are used for slab mill transfer service.



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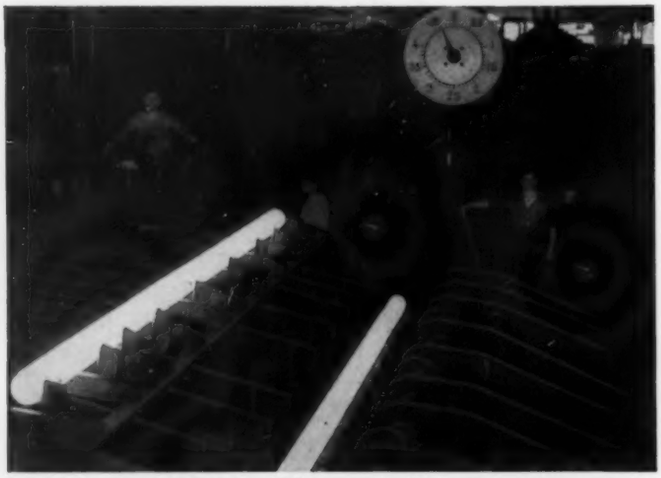

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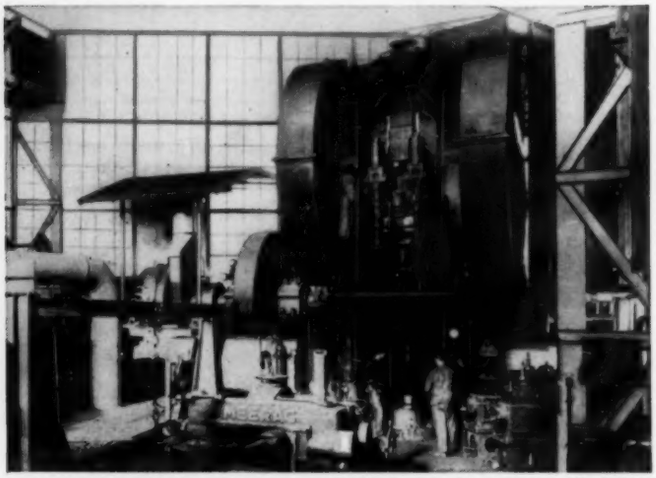

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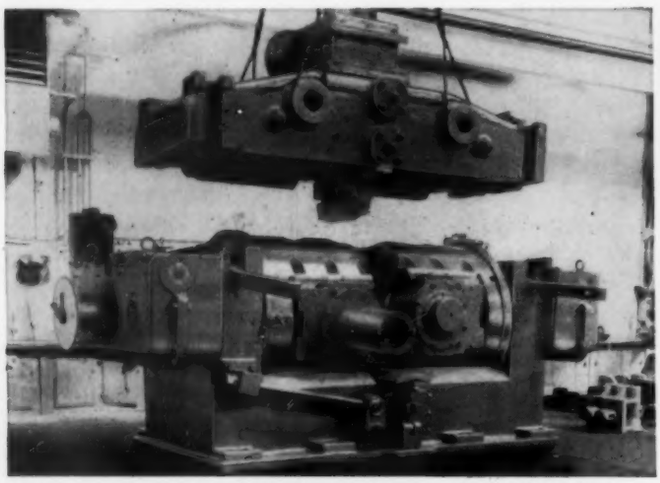

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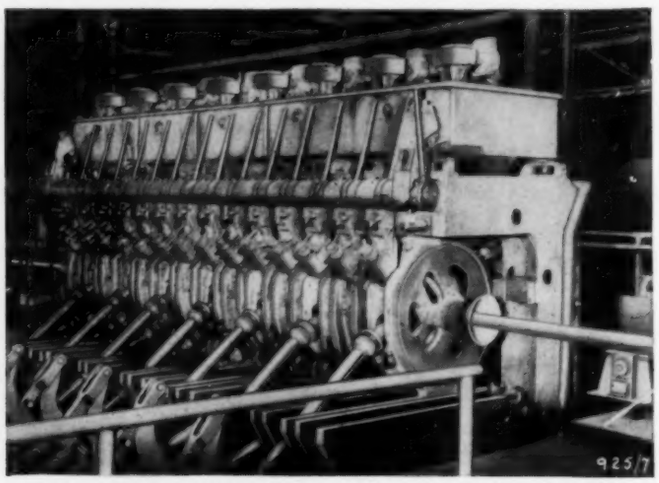

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sidering the slow speeds involved and the design of these bearings, they can generally be mounted opposed for this application with little concern regarding differential expansion. Support of the gear shaft may also be accomplished by sleeve bearings. Generally these are of bronze material and are flanged to provide thrust faces against which hardened steel washers bear.

Use of precision bearings may be dictated by any one of several considerations. Close tolerances on shaft runout or smoothness of motion transmission such as are often encountered in machine tool work may indicate their need. If the gearing is to operate with a minimum amount of backlash, precision bearings may be required to prevent alternate binding and looseness. Similarly, an excessive runout of gears caused by the bearings adversely affects the accuracy of tooth meshing and results in noise and excessive wear when high speeds are involved.

In designing bearing supports, the first consideration is to provide a sturdy means of location to prevent excessive deflections under load. Other factors of major importance are bearing adjustment and ease of assembly for bearings and gearing.

Enveloping of the worm by the gear is a characteristic which vitally affects the assembly of this type of gearing. Because of this, the gear cannot be moved endwise into mesh with the worm. The most common is to move the worm and gear radially into mesh. Assembly in this manner may be accomplished readily if the gear casing is split in plane passing through the centerline of the gear shaft and normal to a line connecting the center of the gear and the center of the worm. If adjacent diameters to the worm threaded section can be so proportioned as to afford clearance, the worm may be screwed into mesh with its enveloping member.

Provision for adjustment of the gearing at assembly is an important factor which many times is completely overlooked. The worm, having threads which are continuous in form, is not critical in regard to endwise location. The gear, however, must be precisely positioned in an axial position. Accumulation of tolerances on the dimensions of housings, shafts, bearings and gears makes it impractical, in most cases, to control the location of the gear by accuracy of machining alone. As a consequence, the correct positioning is normally accomplished by the shimming of the gear at assembly or the machining of parts to suit. The latter method has the disadvantage of losing the benefits of interchangeability, thereby complicating the work required in replacing parts.

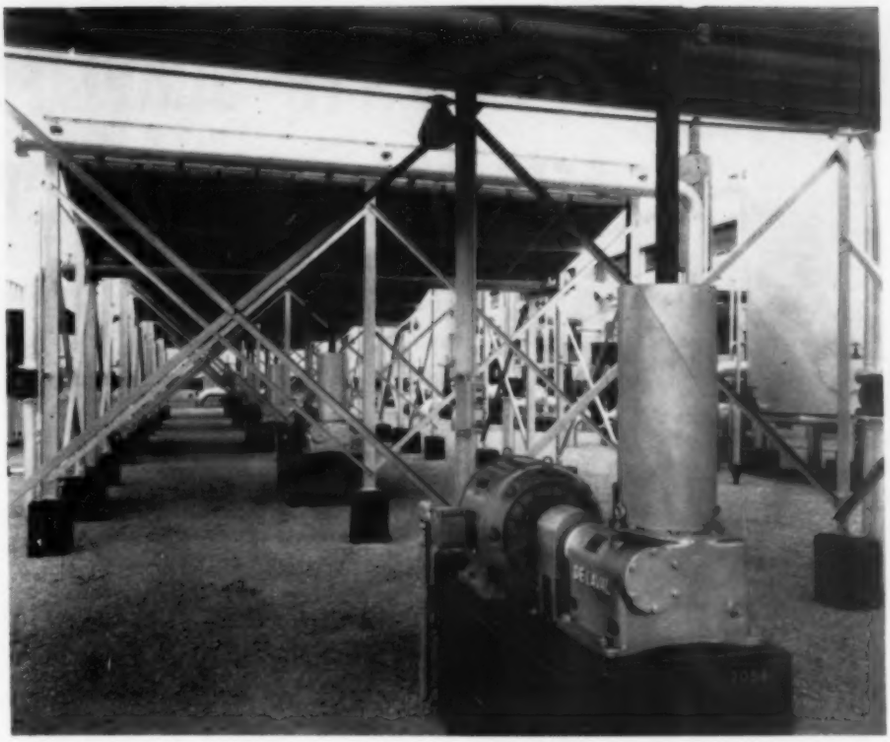

Figure 3 — Vertical worm gear speed reducer shown is used on cooling tower service.

Provision may also be required for the adjusting of bearings. For this purpose, the same methods of shimming or remachining parts to suit may be used. Where bearings such as the tapered roller type are mounted at either end of a gear shaft, shims may be used for the dual purpose of bearing and gearing adjustment.

The gear housing acts as an enclosure to retain lubricant and exclude dirt and moisture, bearing support and a means of heat dissipation. In the most common form of lubrication system, oil contained within the housing is directed by splash to gear mesh and bearings. Natural splash may be augmented by the aid of flingers, scrapers and cups attached to the gear.

Channels or ribs may also be used to direct oil to bearings. In view of thermal considerations, close shrouding of gearing by casing should be used only if operation is intermittent. Where service is continuous and speed is high, ample space around the gearing should be provided to avoid the generation of excessive heat by oil churning and to provide adequate surface for heat dissipation.

Tabulated below are the recommended lubricant levels for splash lubrication:

1. Worm below gear—level at center of worm.
2. Worm above gear—level at one-sixth of gear diameter.
3. Worm beside gear—level at center of worm and gear.

Adjustment of these levels upward or downward may be advisable where conditions of either very low speed or high speed are encountered.

Pressure lubrication is advisable where speeds are high, in order to avoid excessive oil churning. This system also provides a convenient means of cooling by permitting the inclusion of an oil cooler in the piping system when required. The pressure lubrication system may also be used to supply oil to other parts of a machine. In such cases, careful thought must be given to selection of a lubricant suitable for all components.

The information presented here may be used as a general guide for selection and housing of worm gearing. For specific information on any particular design, consult suppliers of this type of gearing, most of whom offer an engineering service based on their manufacturing, design and application experience.

THREAD INSERTS SIMPLIFY HOT MILL MAINTENANCE PROBLEMS

▲ REPAIRING stripped holes in 3-high breakdown mills with wire screw thread inserts eliminates costly damage to mill housings, reduces maintenance downtime 66 per cent, triples running time between overhaul jobs and automatically increases production at the Niles Rolling Mill Division of Sharon Steel Corp., Niles, Ohio.

Figure 1 — Damage to 3-high breakdown mills, caused by loose wearing plates rubbing against mill housings is eliminated by the strong, wear-proof thread connections obtained with wire inserts. Insert-protected holes (marked with X's) also reduce overhaul frequency, reduce mill downtime and increase production.

Damage, caused by loose wearing plates rubbing against mill housings, is eliminated by the strong, wear-proof thread connections obtained with wire inserts. Worn and stripped thread repair time has been cut from 80 man-hours to 24 man-hours. Eliminating rubbing action reduces the frequency of major overhaul jobs from six months to 18 months. With the elimination of thread repair problems and minimizing of overhauls, mill output has increased proportionately.

Corrosive action of coolant water, combined with constant pressures required to operate the mills, caused unprotected threads to wear, strip and loosen. As a result, wearing plates chafed against mill housings, causing excessive damage. To protect costly housing faces from this damage, it was necessary to overhaul breakdown mills twice a year.

The insert, having a slightly larger free diameter than the hole, is compressed before installing with an inserting tool for quick seating in the tapped hole. For this reason, the insert is self-locking. No amount of vibration will loosen the insert, and being stainless steel, it will not corrode. Consequently, wearing plates remain securely attached to housing.

These mills reduce steel plates from 1 in. to sheets as thin as 0.128 in. Back-up rolls, 32 in. in diameter, and work rolls, 22 in. in diameter, are used for this purpose. Steel plates are passed back and forth through the mills from three to five times, depending upon the gauge specification desired. Wearing plates, 17 in. wide, 5 ft 5 in. long, and 2¼ in. thick are secured to housings by 22 bolts, installed in insert protected holes. There are a total of 88 holes as each mill requires four wearing plates.

Figure 2 — Wire thread inserts are easily turned into tapped holes with inserting tool.

The reduction in maintenance downtime was accomplished as follows: Formerly, stripped thread holes were redrilled and tapped for the next larger size. Each successive overhaul required enlarging the hole ⅛-in.

Figure 3 — Temporary thread repairs in one of these mills formerly took 80 man-hours. With inserts, permanent repairs take only 24 man-hours.

Starting with original ¾-in. holes, future repairs would eventually necessitate two drilling and tapping operations, the first being a ⅞-in. hole, and the second a 1-in. hole. When 1-in. holes required repair, they were filled with weld, drilled to the original size, and the same drilling and tapping operations started again. This sequence of operations continued through the life of a breakdown mill. As much as 80 man-hours were often required to complete this repair job.

Now, worn threads are drilled out and retapped, and wire inserts installed to provide permanent threads of the original size. Damaged holes used to be filled with weld before the drill-

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ing, tapping and insert installing operations. No future thread repair will be necessary on the insert-protected holes. Repairing housing faces with wire thread inserts requires approximately 24 man-hours.

Breakdown mills were formerly torn down every six months for the specific purpose of repairing worn and stripped holes in housing faces. In contrast, wearing plates secured ten months ago with wire thread inserts, show no signs of loosening. Therefore, no definite overhaul maintenance need be scheduled. Bolts, securing wearing plates, are subject to failure, and it is possible that they may have to be replaced approximately every 18 months. Hereafter, the necessity for overhaul will not result from tapped thread wear.

Overhaul jobs generally required from 10 to 14 days. Approximately 40 man-hours were required to tear down a mill. The condition of housing faces dictated the amount of work necessary to complete the repairs. Sometimes, 50 to 60 of the 88 holes in the housing face had to be filled with weld prior to drilling. Housings were often damaged by wearing plates and had to be built up in order to provide a level surface. This and other routine maintenance was done while the mills were down. Reassembling the mill required another 48 man-hours.

LE TOURNEAU STEEL PLANT CONTAINS UNUSUAL FEATURES

▲A steel plant that has received little publicity but has been much discussed by those who have seen it is that of R. G. Le Tourneau, Inc., at Longview, Tex. Designed and built by the company primarily to provide steel for its own manufacturing operations, the plant contains innovations departing widely from conventional steel plant practice.

Steel is produced in three 25-ton electric arc furnaces. The shells are of welded construction and are proportionately higher than the usual furnace. Each furnace is supported on the tapping side by trunnions pivoting upon a pier, and on the working side by a fabricated steel saddle. The furnace is tilted by a cable hoist working on a jib boom mounted under the furnace.

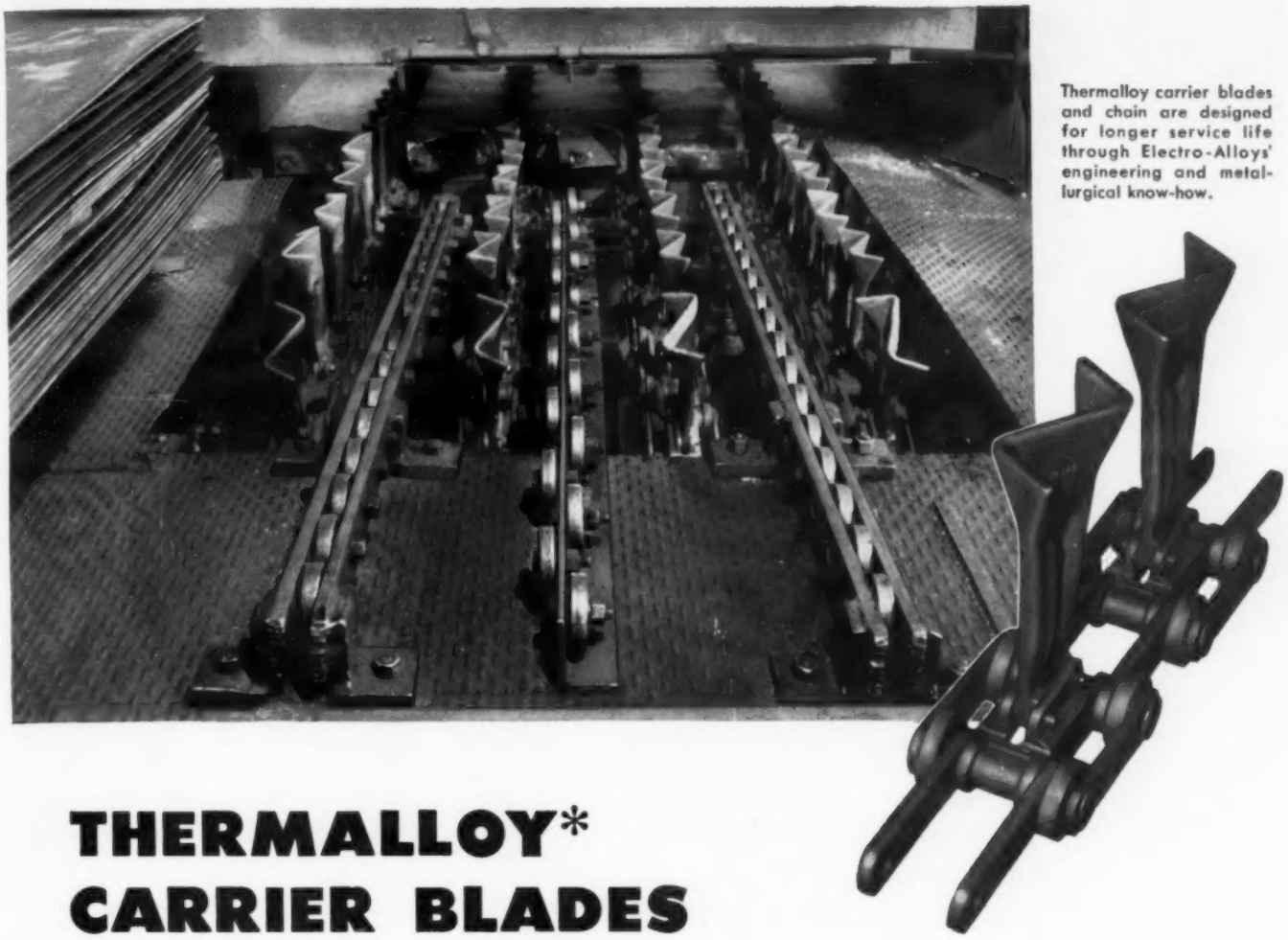
Immediately above the tapping spout is a large charging chute. Scrap is loaded into a large scoop mounted on a larry truck of special design. This scoop is run into the chute on the furnace and a ram pushes the scrap out of the scoop into the furnace.

Figure 1 — The steel mill at the Longview, Texas plant of R. G. LeTourneau, Inc., contains three electric furnaces, each of 45,000-lb capacity. An average of 300 tons of steel a day can be produced.

Power is supplied to each arc furnace by 16 generators, each driven by a 450-hp airplane engine operating on natural gas. Power input, which is at 120 cycles, may range up to 14,000 amp at 400 volts. Rather long leads of relatively small insulated cable carry the power to 16-in. electrodes.

The furnaces are said to produce single slag heats in 3½ hours, and double slag heats in 4½ hours. The steel is tapped into a 30-ton ladle and is top poured, usually to make 7000-lb ingots.

Ingots are heated in a furnace of unusual design, consisting of a brick-lined steel cylinder, 80-ft long and 20-ft in diameter, sloping slightly from the horizontal. Ingots in a double row are pushed down skids located approximately along the middle of the cylinder. A row of burners along each side, tilted up on one side and down on the other, introduce natural gas into the furnace, giving a whirling motion to the gases in the furnace. Heating time for slab ingots 12 in. thick was stated to be 6-7 hours. Through action of the furnace pusher, heated ingots are moved out of



Thermalloy carrier blades and chain are designed for longer service life through Electro-Alloys' engineering and metallurgical know-how.

THERMALLOY* CARRIER BLADES

. . . last 7 times longer than previous design!

Here's how Electro-Alloys' metallurgical and engineering know-how made a difference in the life of carrier blades used in a large steel plant.

In this plant, stainless and silicon steel sheets are heated in a 40-foot furnace where temperatures range from 1500°F. to 2200°F., depending on the type of steel. Carrier blades and chain entering the furnace are subjected to this high heat, and then, sudden cooling to 600°F. occurs as they return under the furnace to renew the heating cycle. Old style carrier blades lasted only three weeks.

Electro-Alloys engineers observed two weaknesses in the previous design. Blade supports tended to bend . . . and carrier tips broke. By redesigning the flat, vertical supports to corrugated shapes, Electro-Alloys eliminated bending. By using a "Z" shape top, which had previously proved successful at another mill, broken carrier tips were eliminated. In its modern foundry, Electro-Alloys cast carrier blades and chain in grades of Thermalloy best suited for this operation. Results were excellent . . . *Thermalloy carrier blades now last nearly seven times as long as the old design.*

It pays to apply the experience of Electro-Alloys . . . and get longer service life from heat-resistant alloy parts by using Thermalloy. To put such knowledge to work for you, just call your nearest Electro-Alloys office, or write Electro-Alloys Division, 5006 Taylor Street, Elyria, Ohio.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

Elyria, Ohio

*Reg. U. S. Pat. Off.

Figure 2 — Molten steel being poured from furnace into ladle. Note unusual arrangement of charging chute above the tapping spout.

Figure 3 — Ladle is discharging molten steel into ingot molds. No horizontal stiffening bands are apparent on ladle.

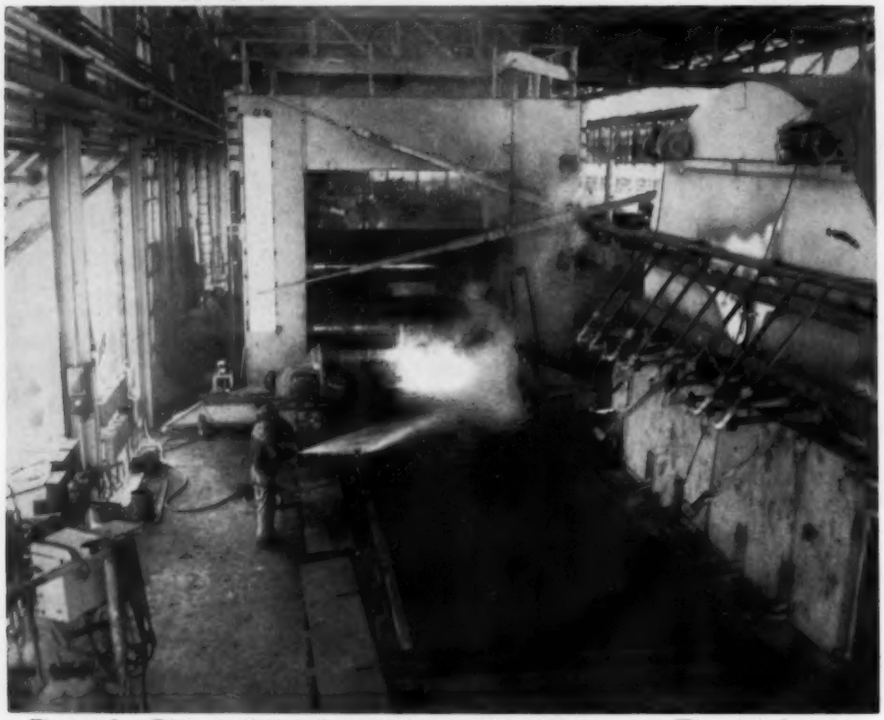


Figure 4 — Plate mill is a four-high reversing 144-in. mill. The slab furnace for the ingots (shown on the right) has a capacity of 50 ingots 12 x 36 x 72-in.

Figure 5 — Close-up of mill shows built-up welded construction.

the furnace onto the mill approach table.

The mill is a reversing, four-high, 144-in. plate mill. The housing is fabricated of heavy steel slabs. Mill screws are driven through a roller chain by four electric motors. The mill itself is driven by eight motors applied to the work rolls, operating on adjustable voltage (330-volt maximum) and receiving power from eight generators, each driven by an airplane engine operating on natural gas. Planetary gearing gives a 10:1 reduction between the motors and the rolls. Hydraulic plungers in the bottom roll chock balances the top rolls. Roll necks run in tapered roller bearings.

Two overhead cranes of 110-ft span (one rated at 150 tons, one at 100 tons) are provided. Each one carries a gasoline-electric unit which furnishes power to the crane motors.

It should be emphasized that all equipment in the steel plant except the airplane engines, the mill rolls and the roll bearings was designed and built by the R. G. Le Tourneau, Inc.

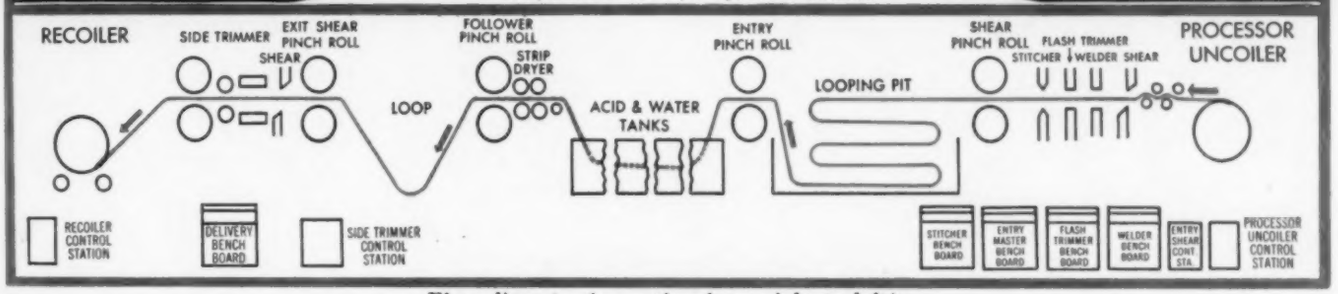
The steel plant is housed in an 88,000 sq ft building located to the rear of the company's Longview manufacturing plant.

Figure 6 — Slab heating furnace is a circular kiln type unit.

Continuous Pickling Line at Pittsburgh Steel is CLARK Controlled

Exit section seen from recoiler

Entry section seen from processor uncoiler



Flow diagram (operation from right to left)

This Wean Engineering Co. continuous pickling line at the Pittsburgh Steel Co.'s Allenport, Pa. mill is powered by 7 DC strip-drive motors and 39 AC auxiliary motors totaling 1409 HP—all efficiently controlled by Clark apparatus.

Designed for a normal operating speed of 500 FPM, this 60 inch combination pickling and side trimming line consists of three sections. The entry section includes the processor uncoiler, shear, welder, flash trimmer, stitcher, and shear pinch roll. The center section includes the entry pinch roll, acid and water tanks, strip dryer and follower pinch roll. The delivery section includes the exit shear pinch roll, shear, side trimmer and recoiler. The control system employs current limit and voltage regulation in all three sections to provide for the most efficient utilization of the available horsepower.

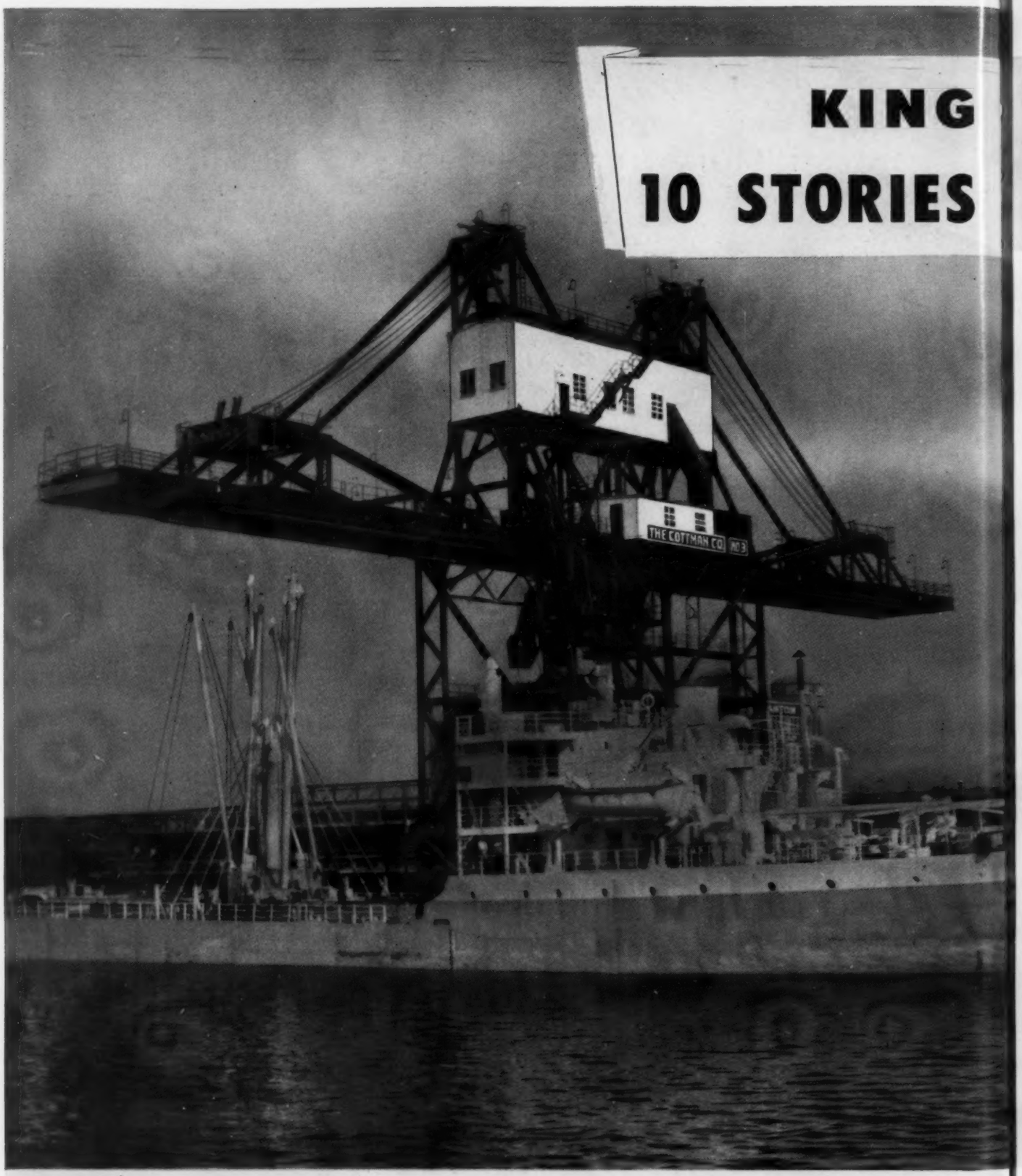
CLARK engineered controls for processing lines are the cumulative result of years of engineering experience. These controls embody the latest circuit designs and devices and are continually being improved to keep pace with production and safety requirements as determined by modern mill practice.

For all types of Processing Lines CLARK engineering "know-how" provides you with dependable, complete control. Consult our nearest District Office for details.

CLARK *Control Panel for Center and Exit Sections*

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO



Ore Bridges
Railroad Car Dumpers
High Lift-Turnover-Rotary
Coal Preparation Plants
Coal & Coke Handling Equipment
Boat Loaders & Unloaders

Rotary Mine Car Dumpers
Coal Crushers
Coal Storage Bridges
Car Hauls & Boat Movers
Bradford Breakers
Refuse Disposal Cars
Thorsten Coal Sampling Systems

Kinney Car Unloaders
Pig Iron Casting Machines
Cyclone Thickeners
Thermal Dryers
Reineveld Centrifugal Dryers
Olivo Moisture Meters

OF THE EASTERN SEABOARD HIGH and HALF A BLOCK LONG

THIS MAMMOTH UNLOADING TOWER...

. . . the fastest ship unloader on the East Coast . . . recently began operations for the Cottman Company at the Canton Railroad Pier, Baltimore, Md.

Designed, fabricated and erected by Heyl & Patterson, Cottman Unloader #3 is the last word in engineering design . . . as modern as next week.

This giant installation again reflects the aim of Heyl & Patterson . . . to work hand-in-hand with the customer to design and build the world's finest Heavy Bulk Materials Handling Equipment.

A contract placed with Heyl & Patterson means just one responsibility for the entire job because we have our own Engineering Department . . . our own Research Department . . . our own Structural Shop . . . our own Machine Shop . . . our own Service Department . . . and our own Erection Department.

When your problem concerns the loading, unloading or transfer of any Heavy Bulk Material, you can depend on Heyl & Patterson to solve it.

FACTS and FIGURES about this NEW HEYL & PATTERSON UNLOADING TOWER

- This new unloader reaches 147 feet above the pier and spans 267 feet between the tips of the two aprons.
- This unloading tower has a maximum or free-digging capacity of 1900 tons per hour.
- The latest engineering and construction designs in this unloader include:
  - Adjustable D.C. voltage control for smoother, better-controlled operation of bucket hoist, trolley and tower travel motions.
  - Turn-table trolley which enables the bucket to dig from any angle in the hold of a ship.
  - Power-operated Heyl & Patterson Rail Clamps installed for added safety.
- The unloader can travel the entire length of the 1250 ft. pier to unload ships from any spot.
- Ships can be unloaded from either side of the pier.
- Ore can be discharged either into railroad cars on the pier tracks or onto a conveyor belt system.
- When traveling, the aprons of the unloader can both be raised to clear the superstructure of ships.
- This is the second Heyl & Patterson unloader now operating on the Canton Railroad pier.
- This new unloader can unload more ore per hour than the combined efforts of the other two unloaders on the pier.

Heyl & Patterson, Inc.

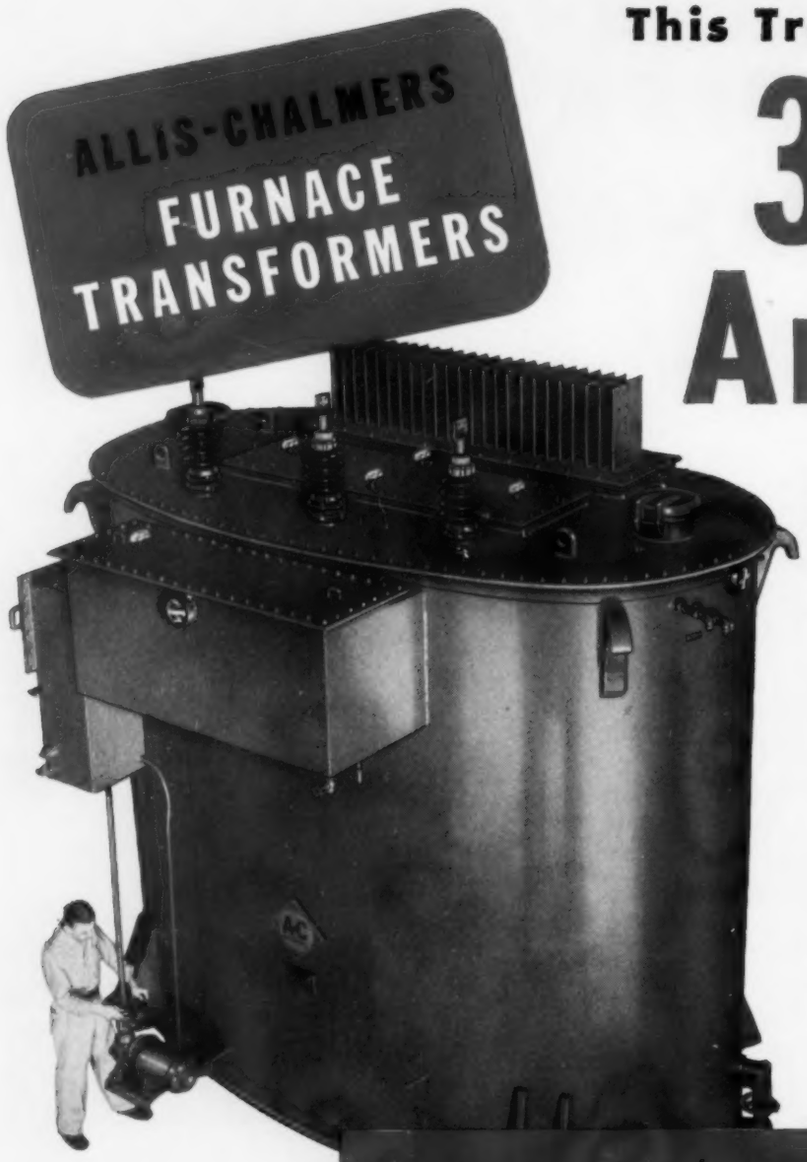
"SINCE 1887"

Heavy Bulk Materials Handling Equipment
All the Way from Design to Erection

55 FORT PITT BLVD. PITTSBURGH 22, PA.

This Transformer Delivers

33,962 Amperes



Providing high continuous current for specialized steel processing is an everyday duty for this transformer. Its well-balanced design and sturdy construction is based on past records of Allis-Chalmers transformers which show ability to withstand as much as 25 to 30 years of the repeated daily short circuits encountered in furnace operation. Allis-Chalmers has been building arc furnace transformers for over 45 years.

In addition to furnace transformers in any rating up to the largest demanded by the industry, Allis-Chalmers builds a complete line of arc furnace electrical equipment, including electrical control, circuit breakers, and auxiliary transformers.

Next time you consider a new or replacement arc furnace transformer, consult the Allis-Chalmers district office nearest you or write Allis-Chalmers, Milwaukee 1, Wis.

A-4318

One of three 20,000-kva arc furnace transformers recently built by Allis-Chalmers for a large eastern steel manufacturer. Each can deliver a continuous current of 33,962 amperes per phase. Picture at right shows core and coil assembly.

- Extremely heavy supports brace coils against severe short circuit stresses.
- Skilful insulation techniques protect windings from overvoltages due to wide tap range. Some units are designed for as much as 50% range in secondary voltages.
- Tap-changing mechanism, specially designed for furnace transformers, is in separate compartment to facilitate periodic inspection and maintenance. Wide, flat contacts provide the long life needed for numerous daily tap-changing operations. Mechanism can be either motor driven or manually operated.
- Grit blasting and three coats of baked-on alkyd resinous paint give transformer good surface protection against industrial corrosion.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

FERROCARBO

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REGISTERED TRADE MARK

THE LADLE ADDITION
that reduces segregation
and improves quality

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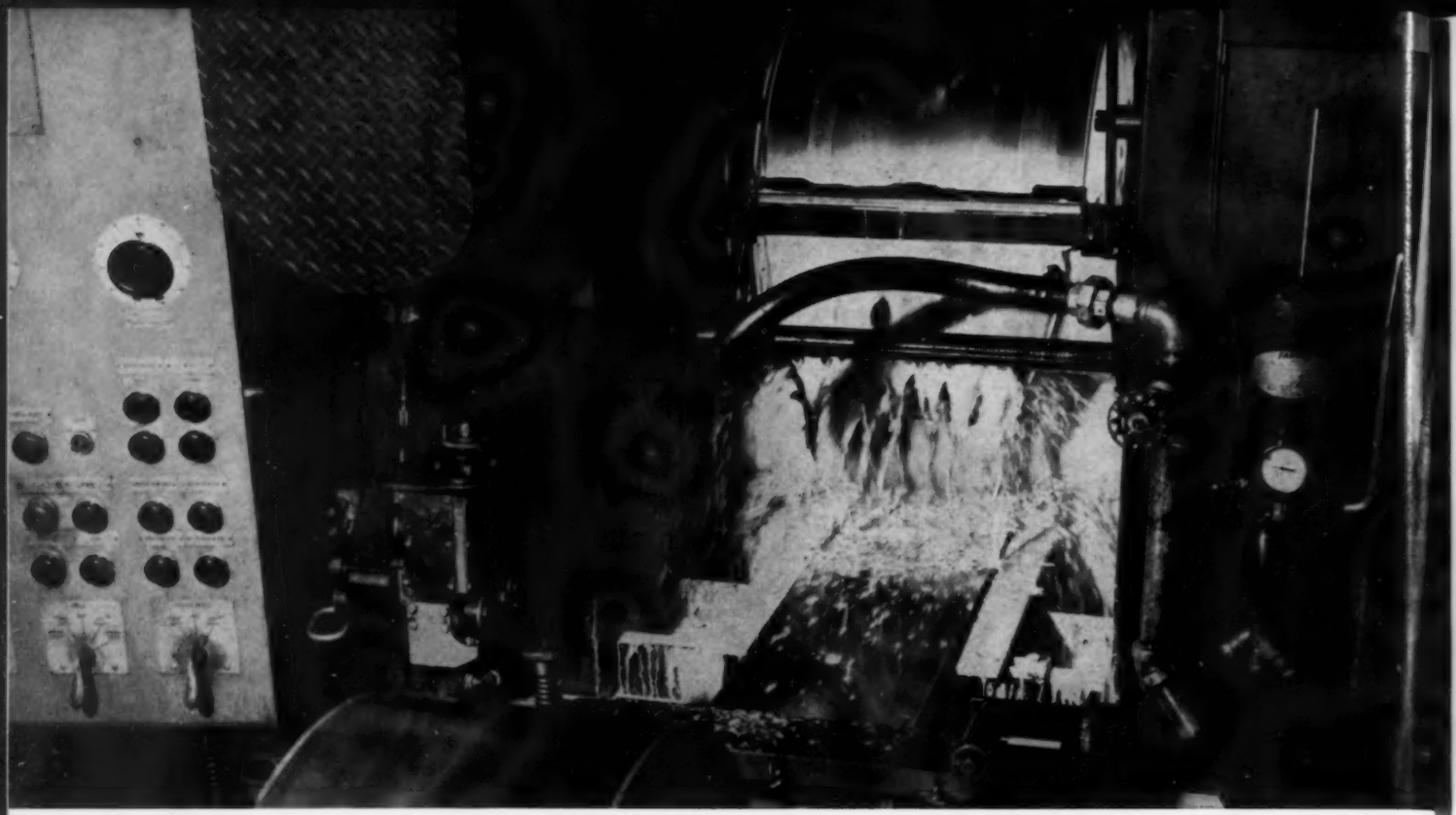


NEW SUNOCO EMULSIFYING ROLLING OIL EASIER TO USE, LASTS LONGER

It mixes readily in hard or cold water—forms whiter and more stable emulsions that can be used for a longer time. The lower viscosity of new Sunoco Emulsifying Rolling Oil makes it easier to pump from storage tanks. These improvements are the result of improved refining techniques made possible by several new multimillion-dollar refining units.

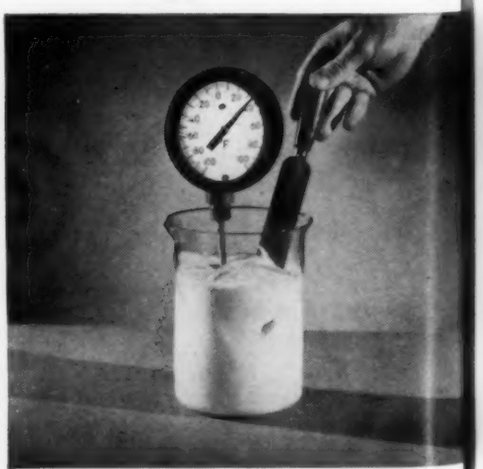
Users report cleaner rolls, reduced spalling, and absence of gumming. The result is lower power consumption and higher mill speeds—as much as 50% in many cases. In the annealing operations, Sunoco Emulsifying Rolling Oil burns off cleanly—usually making cleaning unnecessary. All of these advantages contribute to lower cost operation.

You can also use Sunoco Emulsifying Rolling Oil advantageously for rust proofing hot rolled sheets after pickling, and as a die lubricant in cold drawing steel bars.

The full story about this new oil is well worth your listening. Care to hear it? Just contact your Sun Oil Company representative. Or write Dept. IS-4.

TESTS SHOW HOW READILY THIS NEW OIL FORMS STABLE EMULSIONS

HARD WATER—Tested in dozens of samples of water obtained from industrial plants having hard water problems. Never failed to form a stable emulsion.



COLD WATER—Forms a stable emulsion in the coldest water . . . even ice water.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

SUNOCO

PHILADELPHIA 3, PA. • SUN OIL COMPANY LTD., TORONTO & MONTREAL

Made by the refiners of famous Blue Sunoco Gasoline and Dynalube Motor Oils

Give Long Trouble Free Service

McDanel Porcelain Combustion Tubes and Zirco Tubes are precision made. Density, bore size, wall thickness, etc, are carefully controlled to assure maximum resistance to thermal shock, accurate fit and gas tightness. Cast as a single unit, they defy devitrification—give longer service and lower replacement costs. For carbon and sulphur determinations, McDanel Tubes are TOPS.

Refractory Porcelain Specialties in stock or designed to meet specific needs. Flasks, retorts, crucibles, etc. and parts "custom-made" to do the job.

Write Today for Catalog
"McDanel Industrial Porcelains"

McDANEL Industrial PORCELAINS
McDANEL REFRACTORY PORCELAIN CO.
BEAVER FALLS, PENNA.

MARK FLATS AND ROUNDS
THE SAFE EASY WAY

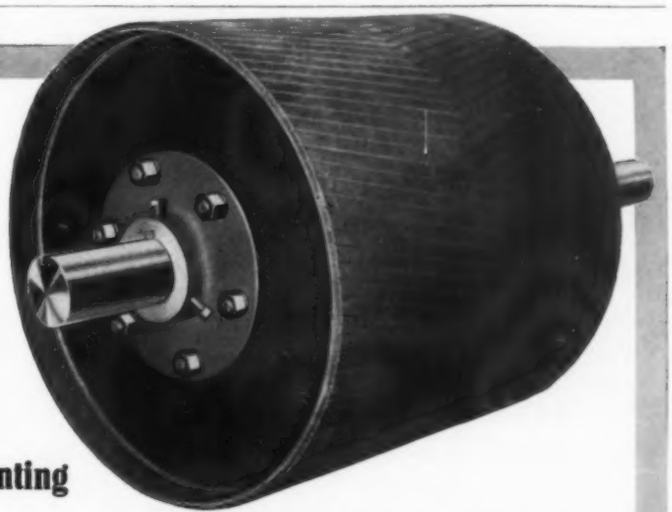
Designed for marking hot or cold products, this unit features a reinforced outer box which levels the type holder on the piece being marked. The type holder is made of Mecco Safety Steel to give maximum resistance to spalling and mushrooming—thereby assuring greatly increased service life. Made for any size type.

Write for literature

Mecco SAFETY BOX TYPE HOLDER

Mecco SAFETY MARKING TOOLS
M.E.CUNNINGHAM CO.
1041 CHATEAU STREET, PITTSBURGH 33, PA.

Take this step to insure pulley keyseat alignment

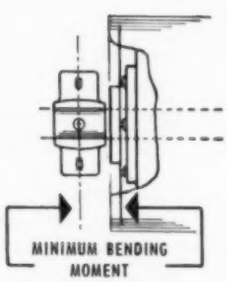


Link-Belt line includes welded steel and gray iron pulleys as well as welded steel slat pulleys. Choose from bolted or taper lock hubs.

Get LINK-BELT factory-assembled pulleys and shafts--take the work out of field mounting

IN addition to speeding field assembly and assuring alignment, Link-Belt factory-mounted pulleys have flush-hub design. The resulting minimum shaft deflection means better belt conveyor operation for you.

Whether your job calls for straight or crowned face . . . plain or herringbone vulcanized lagging —Link-Belt has popular sizes in stock. Call your nearby Link-Belt representative today for complete information.

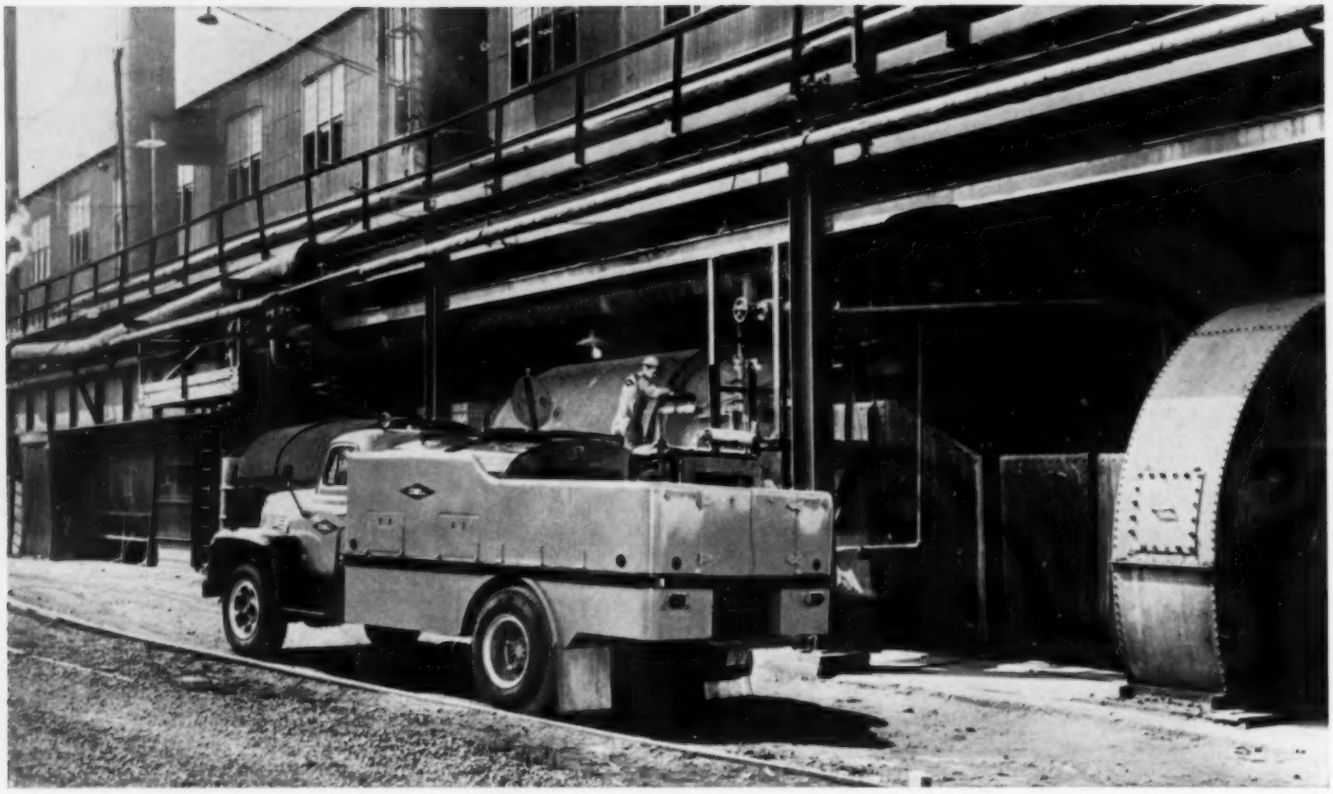


Flush hubs minimize deflection, cut hub bolt stress and disc deflection.

LINK-BELT
13.430-A

WELDED STEEL CONVEYOR PULLEYS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



WASTE HEAT BOILER CLEANED BY DOWELL IN 13 HOURS

Inspection after chemical cleaning showed boiler free of scale—danger of burning tubes minimized

The water side of a waste heat boiler had become fouled with scale. Cleaning of the unit was necessary to avoid the risk of burning the tubes. Dowell was called to do the job.

In just 13 hours, Dowell engineers cleaned the 6,000-gallon capacity boiler, using chemical solvents. The unit was found to be metal-clean upon inspection after the job was completed—thus the risk of burning the tubes was reduced to a minimum.

Many types of boilers, heat exchange and process equipment have been cleaned by Dowell's chemical methods . . . *without dismantling and with a minimum of downtime.* This service has saved thousands of man-hours and helped to prevent costly repairs and replacements.

Perhaps chemical cleaning could improve the efficiency of equipment in your plant. Dowell engineers do the job for you. They bring specially prepared solvents in truck-mounted tanks right to the job, along with all necessary pumping and control equipment. They apply the liquid solvents according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. The chemicals go wherever steam and water flow, reaching surfaces inaccessible to other methods. Often equipment may be cleaned while in operation.

A Dowell engineer will be happy to discuss your cleaning problems with you—make estimates, if you wish—no obligation, of course. For more facts about Dowell Service, call the nearest of more than 130 offices, or write directly to Department D-29, DOWELL INCORPORATED, TULSA 1, OKLAHOMA.

DOWELL SERVICE

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

March 1

▲ Merritt-Chapman and Scott Corp. acquired a 77 per cent interest in the Newport Steel Corp., Newport, Ky.

▲ The AISI reports operating rate of the steel industry for the week starting March 1 is scheduled at 70.5 per cent of capacity. This is equivalent to 1,682,000 tons as compared with 1,756,000 tons one week ago and 2,262,000 tons one year ago. Index of production for the week is 104.7.

March 2

▲ Tin jumped 1¼¢ per lb to 87¢ in New York.

March 3

▲ The House Ways and Means Committee voted to continue the present 52 per cent corporation tax until April 1, 1955. Present law would drop rate to 47 per cent on April 1.

▲ A report by the Dept. of Commerce showed a drop in personal income receipts of $2,000,000,000 for the annual rate in January from $282,500,000,000 in December.

March 4

▲ Electromanganese Corp. reduced electrolytic manganese 1½¢ per lb effective March 1.

▲ The Commerce Dept. announced total manufacturers' sales in January of $22,900,000,000 which was $1,100,000,000 below January 1953.

▲ According to Charles F. Honeywell, head of the Business and Defense Services Administration, machine tool shipments this year will top $1,000,000,000 compared with $1,200,000,000 in 1953.

March 5

▲ The Pennsylvania Railroad reported a net loss of $3,400,000 in January with the same trend in February.

March 8

▲ The AISI reports operating rate of the steel industry for the week starting March 8 is scheduled at 68.9 per cent of capacity. This is equivalent to 1,642,000 tons compared with 1,686,000 tons one week ago, and 2,284,000 tons one year ago. Index of production for the week is 102.2.

March 9

▲ Great Lakes Steel Corp. rehired 1100 of the 1900 hourly employees laid off last January, lifting their hourly employment to 10,200.

▲ The Lone Star Steel Co. plans to revamp its RFC debt, resulting in earlier dividends to stockholders, and materially strengthen its working capital position.

March 10

▲ The ARCI announced deliveries of new domestic freight cars in February 1954 totaling 3974 compared with 4944 in January and 7780 in February 1953. Orders in February totaled 2057. Backlog of cars on order on March 1 was 25,441.

▲ Weirton Steel Co. lowered the price of its structural steel shapes by $5 a ton bringing it to $82, in line with the price of most producers.

▲ Sales of General Motors for 1953 topped $10,000,000,000, the greatest ever reported by any corporation. Profits, however, were only third greatest at $6.71 a common share compared with $6.25 in 1952.

▲ In New York, lead advanced ¼¢ per lb to 12¾¢, and in St. Louis it rose to 12.55¢ per lb. This reversed the downward trend which began last September.

▲ According to the Commerce Dept., January sales of manufacturers, wholesalers and retailers fell to $43,300,000,000, off 12 per cent from December and 5 per cent from January 1953.

▲ Lead moved up ¼¢ to 13¢ a lb in New York. In East St. Louis, zinc advanced ½¢ to 9¾¢ per lb.

March 12

▲ The Aluminum Association announced production of primary aluminum in January at 232,493,207 lb as compared with 220,582,988 lb in December 1953 and 179,790,195 lb in January 1953.

▲ The U. S. Steel Export Co. reduced its export prices for hot-rolled bars, hot-rolled concrete reinforcing bars, sheets, galvanized sheets, wire, nail and staple prices by $1 to $10 a ton.

▲ Industrial stocks in the Dow-Jones are closed above 300 for the first time since 1929 and advanced to 300.83, up 1.24 points, or 0.41 per cent. Utilities spurted to a new high from 0.54 to 55.83 per cent.

▲ Building outlays threaten to outstrip last year's record of $34,700,000,000 according to the Bureau of Labor Statistics.

▲ The AISI reported steel production in February fell to 7,083,000 tons, off 868,486 tons from January and 1,800,000 tons less than in February 1953.

March 13

▲ A report from Union Carbide and Carbon Corp. reports an increase in the price of ferrocolumbian by $3.10 per lb of contained columbian. The new base price will be $9.50 per lb effective April 1.

▲ The F. W. Dodge Corp. reports Construction contracts awarded in the 37 eastern states set an all-time high in February with a gross figure of $1,221,260,000, up 7 per cent above the previous high set in February 1951 and 20 per cent above February 1953.

March 14

▲ United Engineering and Foundry Co.'s net income for 1953 amounted to $3,806,031 or $1.51 a share compared with $3,772,906 earned in 1952. Sales in 1953 totaled $80,702,298 compared with record 1952 figures of $85,097,534.

March 15

▲ The Commerce Dept. estimated total business inventories at $80,000,000,000 on January 31 compared with $76,500,000,000 one year earlier.

▲ Unemployment for February was the highest since 1950.

▲ Lead and zinc prices advanced ½¢ from one week ago.

▲ The International Nickel Co. of Canada, Ltd. reports net earnings in 1953 at $53,694,526 or $3.54 a share compared with $58,891,282 in 1952.

▲ Superior Steel Corp. reported sales totaled $37,810,816 during 1953 which surpassed its 1952 sales of $28,649,796 by 32 per cent.

▲ The AISI reports operating rate of the steel industry for the week starting March 15 is scheduled at 67.8 per cent of capacity. This is equivalent to 1,616,000 tons as compared with 1,652,000 tons one week ago and 2,288,000 tons one year ago. Index of production for the week is 100.6.

March 16

▲ Price of platinum took a cut of $6, down to $84 per ounce in bulk quantities and to $87 an ounce in retail lots.

▲ The Dow Chemical Co. announced lower prices for magnesium sheet and plate with reductions up to 25 per cent.

March 18

▲ The Securities and Exchange Commission and the Commerce Dept. estimated business firms plan to spend $27,200,000,000 for new plant and equipment in 1954, or 4 per cent less than that spent in 1953.

▲ World total production of steel ingots in 1953 hit a new high of 254,700,000 tons, 22,000,000 tons above 1952, according to a report of the Business and Defense Services Administration.

▲ The first full-scale atomic-powered electric plant will be built by Duquesne Light Co. in Pittsburgh. Research development and construction will be done by Westinghouse Electric Corp.

▲ Alcoa's consolidated net income for 1953 was $48,848,094 compared to $43,527,142 in 1952; net income per share in 1953 amounted to $4.71 compared to $4.19 in 1952; and revenues from sales, services and other sources in 1953 were $711,073,898 compared to $584,005,750 in 1952.

▲ A report of the AISI stated average hourly payroll in the iron and steel industry for January was $2.294 which was 7.8¢ higher than for January 1953. Employment in this industry was estimated at 644,900 in January as compared to 683,800 in January 1953.

▲ Consumption of ferrous materials (scrap and pig iron) in the United States during 1953 reached an all-time high of 135,663,000 gross tons, according to the Bureau of Mines, United States Department of the Interior.

March 19

▲ A 10 per cent boost in railroad rates for handling U. S. mail was granted railroads by the Interstate Commerce Commission which means an increase of $32,500,000 in revenues.

▲ The House defeated a Democratic drive to cut personal income taxes by granting an extra $100 exemption to each taxpayer and dependent.

▲ CIO delegates in Pennsylvania voted unanimously in support of a 6-hr day, 30-hr week with no reduction in pay.

▲ According to the Engineering News-Record, heavy construction contracts for the week ending March 18 dropped to $215,000,000 from the $245,000,000 one week earlier.

▲ A report from the Aluminum Association states that primary aluminum production in the United States totaled 220,965,786 lb for February as compared to 185,297,920 lb for February one year ago. Production in January 1954 was 232,493,207 lb.

March 22

▲ On sales of $514,474,000, net earnings of $21,943,569 equal to $6.58 a common share were disclosed by Allis-Chalmers Manufacturing Co. for 1953.

▲ Inland Steel Co. plans an expansion program in 1954 amounting to $35,000,000.

▲ The AISI reports operating rate of the steel industry for the week starting March 22 is scheduled at 66.5 per cent of capacity. This is equivalent to 1,585,000 tons compared with 1,613,000 one week ago and 2,324,000 tons one year ago. Index of production for the week is 98.7.

March 23

▲ The AISI reported shipments of finished steel in January totaled 5,727,600 net tons, about 43,000 tons more than the previous month.

March 25

▲ Secretary of the Treasury, George Humphrey, ordered $16,000,000 worth of Czechoslovakian-owned steel rolling mill equipment to be put up for auction. Delivery of this equipment to the Czechs was blocked in 1948 to safeguard U. S. defense interests.

▲ Electro Metallurgical Co. announced lower prices for some of its ferrosilicon products today.

▲ The Interstate Commerce Commission granted eastern railroads permission to cut rates on iron and steel products by 15 per cent in an effort to meet truck competition.

▲ Republic Steel Corp. reached an agreement with Fiat of Turin, Italy whereby the Italian firm will produce Republic's stainless and heat resisting steel in all grades at its plant in Turin for Italian consumption.

▲ A report from the American Institute of Steel Construction stated February bookings of fabricated structural steel amounted to 267,310 tons. February shipments were 251,981 tons. Backlog of work ahead as of February 28 stands at 1,697,313 tons.

March 26

▲ The Committee of Stainless Steel Producers of the AISI reported stainless steel production figures for 1953 shows an all-time high of 1,015,303 tons which was a net increase of 85,139 tons over the 1952 production.

▲ The United States agreed to purchase 100,000 tons of copper from Chile at the world market price.

March 29

▲ The Colorado Fuel and Iron Corp. signed an agreement whereby Continental Oil Co. may explore an area of about 170,000 acres of its land for oil and gas.

▲ The AISI reports operating rate of the steel industry for the week starting March 29 is scheduled at 68.0 per cent of capacity. This is equivalent to 1,621,000 tons as compared with 1,624,000 tons one week ago, and 2,190,000 tons one year ago. Index of production for the week is 100.9.

March 30

▲ Zinc advanced ½¢ to 10¼¢ per lb in East St. Louis while lead advanced ¼¢ to 13½¢ per lb in New York.

▲ The Ward's Automotive report stated auto makers have scheduled 1,521,000 cars for the second quarter, a 7 per cent gain over the previous three months.

▲ According to the Commerce Dept., manufacturers sold $23,000,000,000 worth of goods in February, $1,100,000,000 less than February one year ago.

▲ President Eisenhower signed a bill to cut excise taxes by $999,000,000 yearly in order to help stimulate business.

▲ The Senate Labor Committee approved a 12-point Taft-Hartley bill which incorporated most of Eisenhower's recommendations except the one requiring employee strike votes.

▲ Mystic Iron Works in Everett, Mass. lowered pig iron prices by $1.75 per ton.

▲ Steel shipments to the automotive industry in January were 122,505 tons, the highest since last September.

▲ The Kaiser Aluminum and Chemical Co. announced production of 48-in. wide corrugated aluminum farm roofing and siding.

▲ Price reductions were announced by Du Pont for Grade A ductile titanium metal sponge of 6 per cent to $4.72 a lb and 11 per cent for Grade A-2 to $4.46 a lb.

25-Ton, 72-ft. span Bedford Crane over the mold yard in Detroit Steel Corporation's new mill at New Boston (Portsmouth), Ohio.

Bedford Cranes continue to gain favor with steelmakers

Repeat orders tell the story: in steel mills, power plants, throughout heavy industry . . . wherever superior performance is demanded . . . men who know equipment are re-ordering Bedford Cranes.

For these men know from experience that Bedford Cranes — backed by over a half-century of specialized crane building and utilization experience — will deliver consistent top-notch performance through the years. They know every advanced design feature of a Bedford Crane will pay off in safer, smoother, more dependable operation—and they know that every Bedford Crane installed in their plant will be individually engineered and precision built for its specific application.

You are invited to consult a Bedford Engineer on your next crane problem . . . with all the facts on the table, we believe you too will make *your* next crane a Bedford . . . available in all types and sizes, from 5 to 350 tons and up.

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STEEL MILL CRANES
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...the choice of leaders in industry

Meet changing load demands with

Wagner Dry-Type Transformers

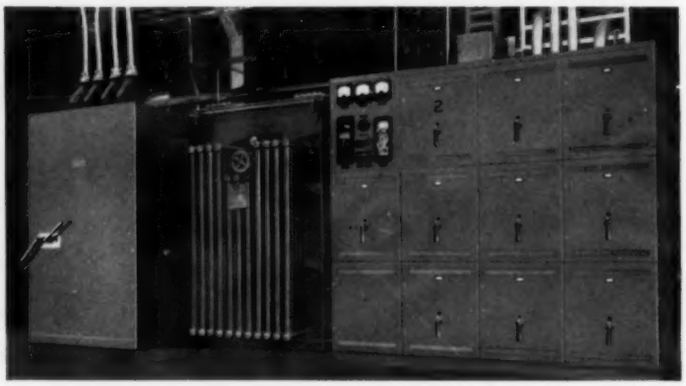
Wagner dry-type transformers can solve your problems by putting the right voltage close to the load wherever machines, portable tools or lights require voltage changes.

SAFE- Wagner dry-type transformers meet all requirements for indoor installation. They will save you money on insurance premiums. Fireproof vaults or other special protection are unnecessary—even where fire hazards are present.

ECONOMICAL- when you use Wagner dry-type transformers, you reduce installation costs—you reduce line losses—you eliminate long runs of secondary copper—and you can forget about maintenance.

COMPACT- Wagner dry-type transformers are small in size—light in weight—easy to install and easy to move whenever changes in plant facilities make it necessary.

Wagner general-purpose dry-type transformers are available in single-phase units, 600 volts and below, in sizes 1, 1½ and 2 kva—55° C Rise; and in sizes 3 to 100 kva—80° C Rise. Write for Bulletin TU-57.



Unit Substation Transformers

for load-center power distribution

Wagner three-phase dry-type load-center transformers are built in ratings through 2000 kva in the 15-kv class and below. Transformer and incoming line section are housed in compact factory-matched enclosures, designed for direct connection to matching secondary switchgear to form a closely coupled unit substation that is streamlined in appearance and readily accessible. Complete enclosure of all equipment assures safety against contact with live parts.

Bulletins TU-56 and TU-13 give full information on Wagner Dry-Type and Liquid-Filled Substation Transformers. Write for your copies.

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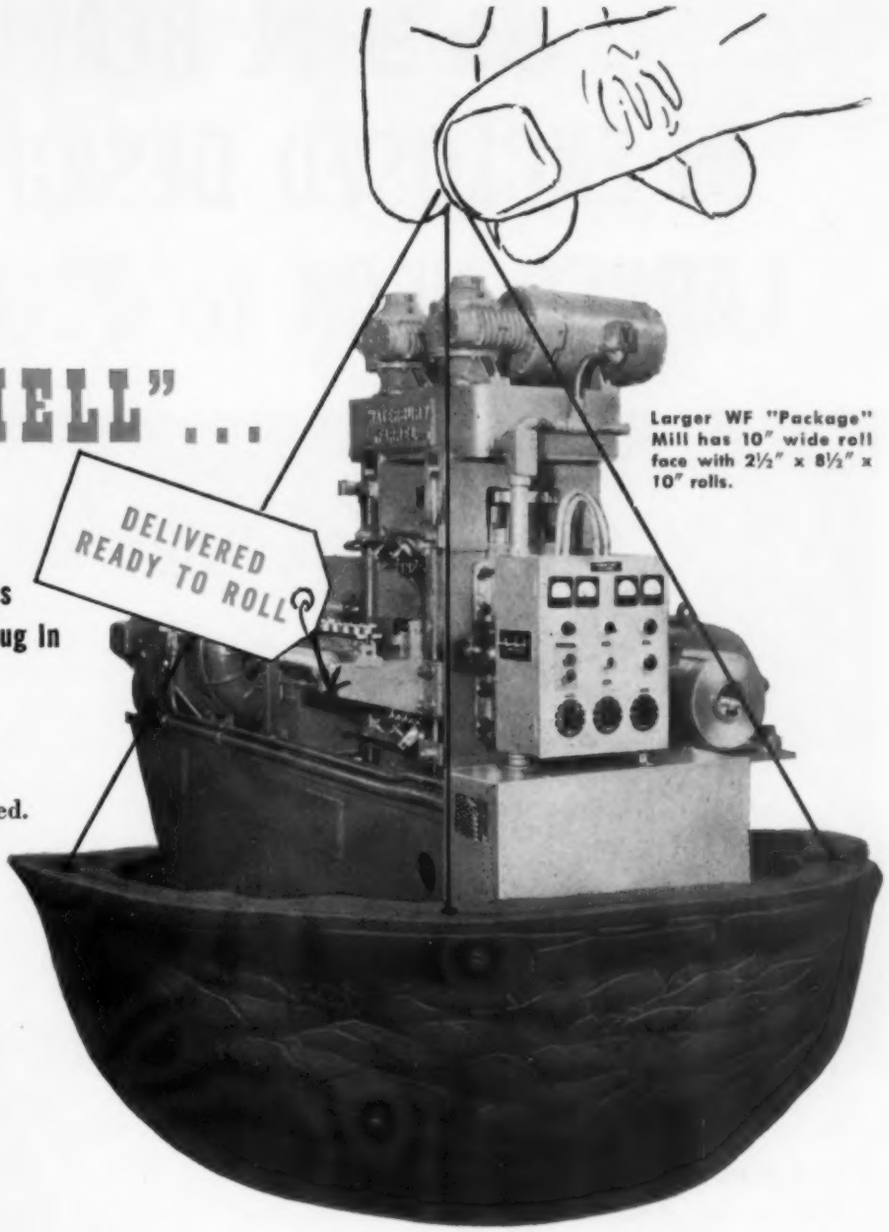
T54-1A

Waterbury Farrel's New, ONE-PIECE

STRIP MILL "IN-A-NUTSHELL" . . .

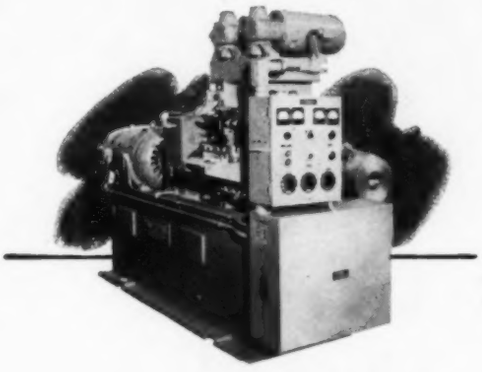


Larger WF "Package" Mill has 10" wide roll face with 2½" x 8½" x 10" rolls.

WF's 4-High "Package" Rolling Mills Are Compact, Low Cost, Ready To Plug In

You can start precision-rolling ferrous or non-ferrous strip as soon as you plug in the electrical connection.

This mill is completely self-contained. Drive, gear case, controls, lubrication system, winder and winder drive are assembled with the mill, itself, into a single, compact unit. When necessary, it can easily be moved in one piece to a new location.



Smaller WF "Package" Mill has 6" wide roll face with 1⅝" x 6½" x 6" rolls.

Some Construction Features: Mill frame of unit welded plate steel gives maximum strength and rigidity . . . assures greater accuracy and lasting alignment . . . alloy steel work rolls mounted in needle bearings . . . alloy steel back-up rolls drilled for water cooling, mounted in double row Timken bearings with tapered sleeve . . . independent power screwdowns . . . long and short roll necks and staggered couplings permit heavier construction for maximum torque capacities . . . lucite cover on welded steel gear case facilitates inspection . . . variable speed tension control drive, using AC power, cuts control cost and permits compact panel.

Contact Waterbury Farrel for complete details. No obligation.

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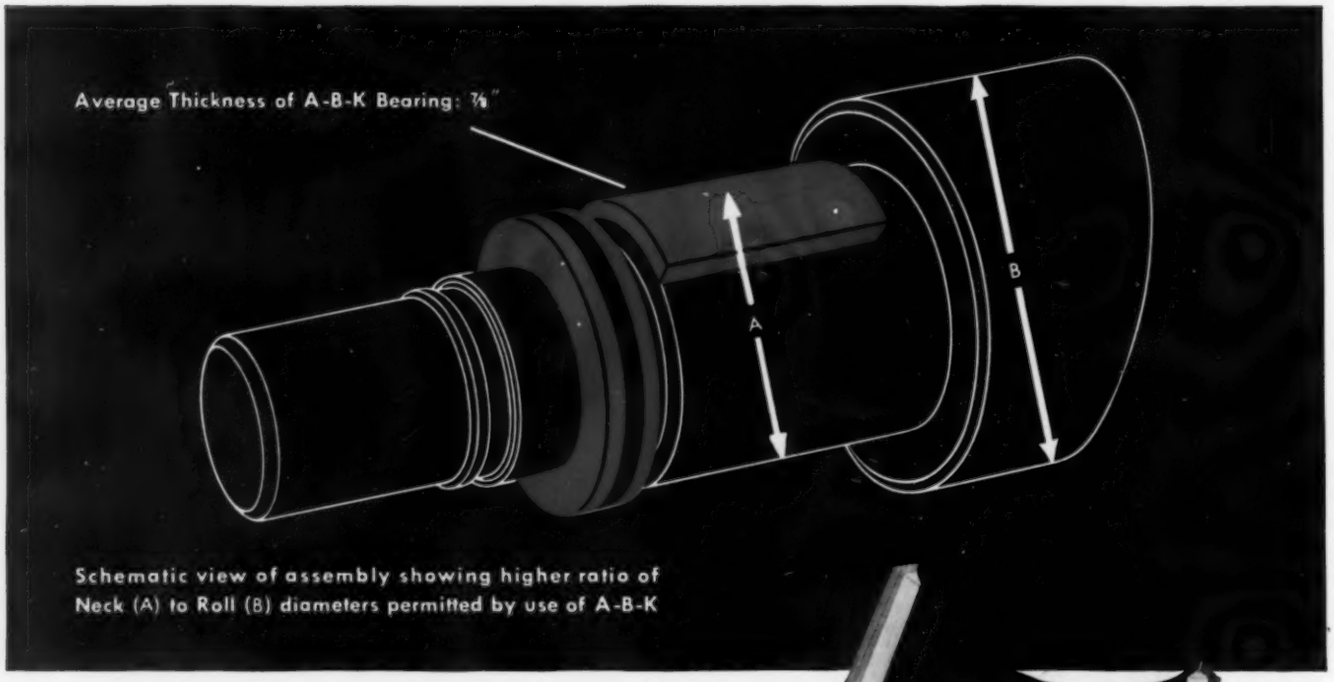
A FEW OF THE MANY TYPES OF METAL WORKING MACHINERY MADE BY WATERBURY FARREL

MILL MACHINERY—Rolling Mills: Strip, Rod, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Cailers • Winders, etc. *WIRE MILL EQUIPMENT*—Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers Swagers • Bull Blocks • String-up Machines • Spoolers, etc. *COLD PROCESS BOLT & NUT MACHINERY*—Headers (all types) • Rivet Machinery • Trimmers • Thread Rolling Machines • Slotters • Nut Formers and Tappers, etc. *POWER PRESSES*—Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.

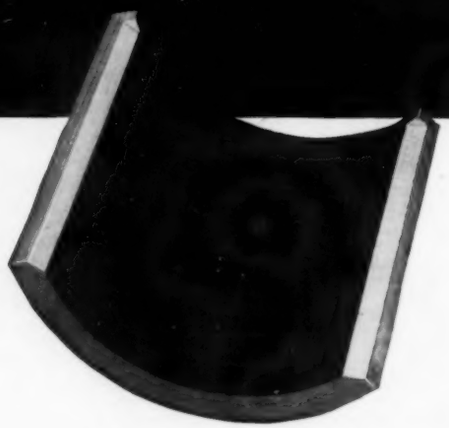
WATERBURY FOUNDED 1851 FARREL

WF-17

A-B-K BEARINGS IN ENCLOSED DESIGN PERMIT LARGER NECK to ROLL RATIOS!



Schematic view of assembly showing higher ratio of Neck (A) to Roll (B) diameters permitted by use of A-B-K



A-B-K laminated fabric bearings save space! Permit the design of compact assemblies with larger and stronger roll necks . . . less expensive, lighter weight parts.

A-B-K bearings cushion impact loads, wear longer in many applications. These fabric bearings are simple to store, easy to handle. They reduce maintenance and replacement costs. Grease or oil can be used for lubrication but water *alone* is often the answer.

Our engineers will be glad to help you take advantage of A-B-K for new mill equipment or old. Write us about your applications today.

A-B-K®
LAMINATED FABRIC BEARINGS

AMERICAN Brake Shoe COMPANY

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AMERICAN BRAKEBLOK DIVISION
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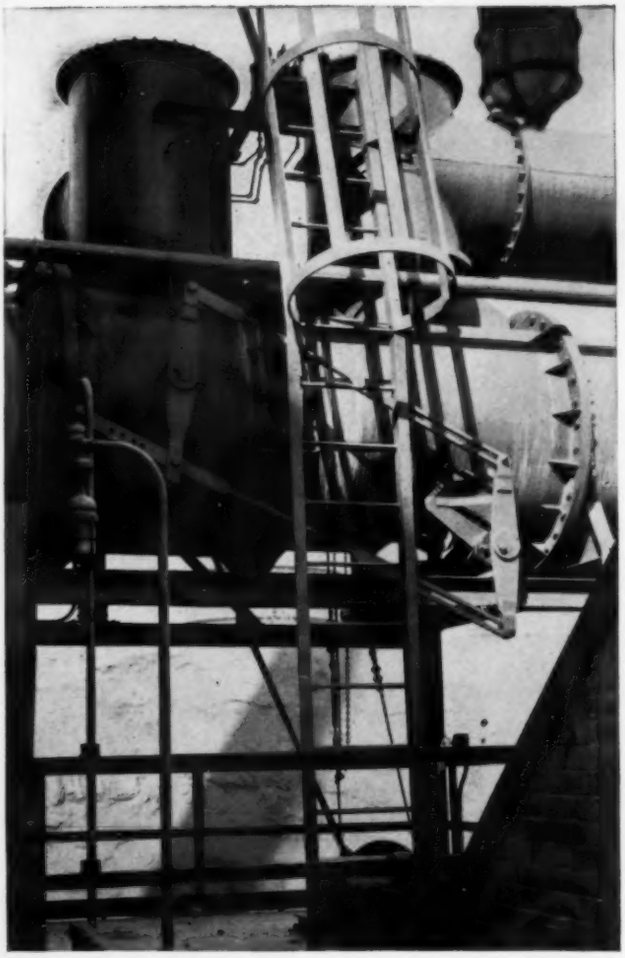
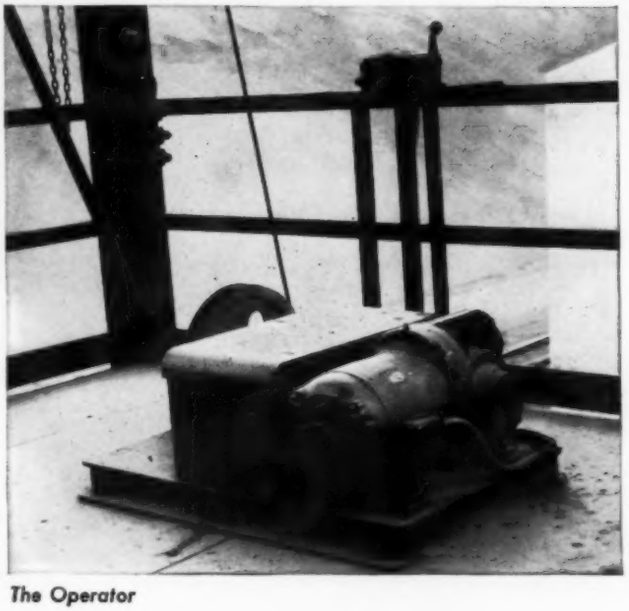


The Complete Assembly



The Operator

Blast Furnace SNORT VALVE may now be MOTOR OPERATED

- The operator is adaptable to a variety of valve designs.
- Existing valves may be electrified.
- Mechanical operation of the valve is preserved intact.
- Electrical operation is the normal mode. In the event of power failure, reversion to manual operation is automatic.
- A small master switch supplants the hand wheel.
- Multiple stations for electrical operation are provided.
- Quicker response, easier control.

SUCCESSFUL OPERATION DEMONSTRATED

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KOPPERS BUILDING • PITTSBURGH 19 *Associated with* Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND De Lattre & Frouard, Paris, FRANCE

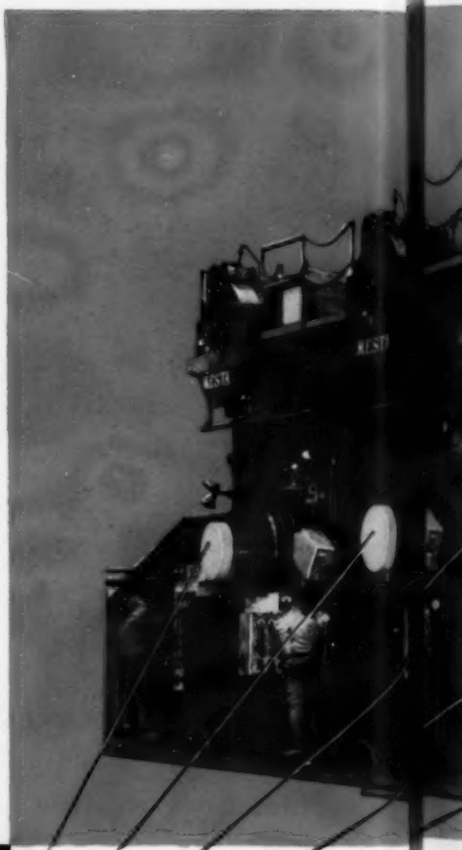
Back-up roll bearings of get effective lubrication with GULF I-C

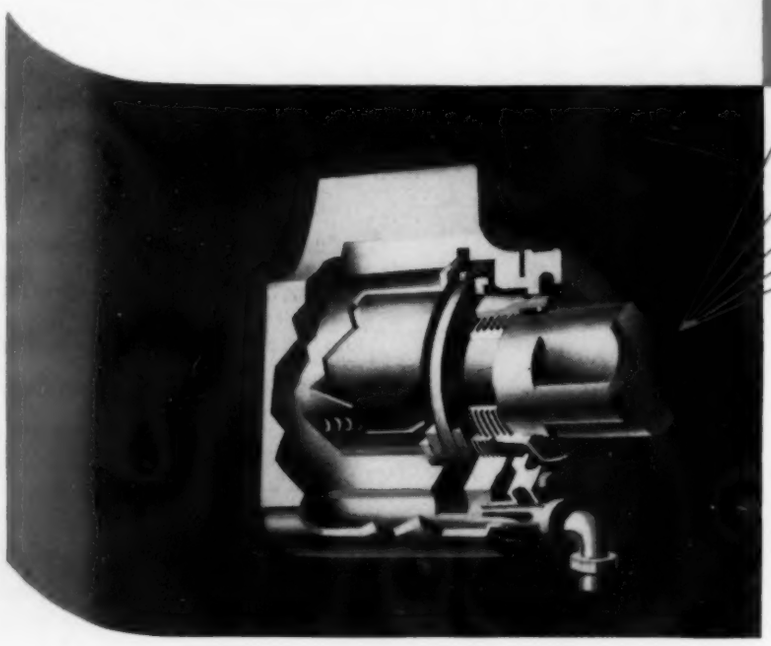
Back-up roll bearings of this cold strip mill at U.S. Steel's new Fairless Works, the world's fastest, require the best possible lubrication to withstand heavy loads over a long period of time. The strip shoots through the rolls at speeds up to 7000 feet per minute.

Gulf I-C Oil provides the effective lubrication that is needed here. This stable oil has excellent water separating characteristics, and resists sludge formation. These important advantages—plus outstanding lubricating qualities—contribute to continuous operation and lower maintenance costs.

Gulf I-C Oil was also selected to lubricate the back-up roll bearings of the new and efficient hot strip mill at the Fairless Works.

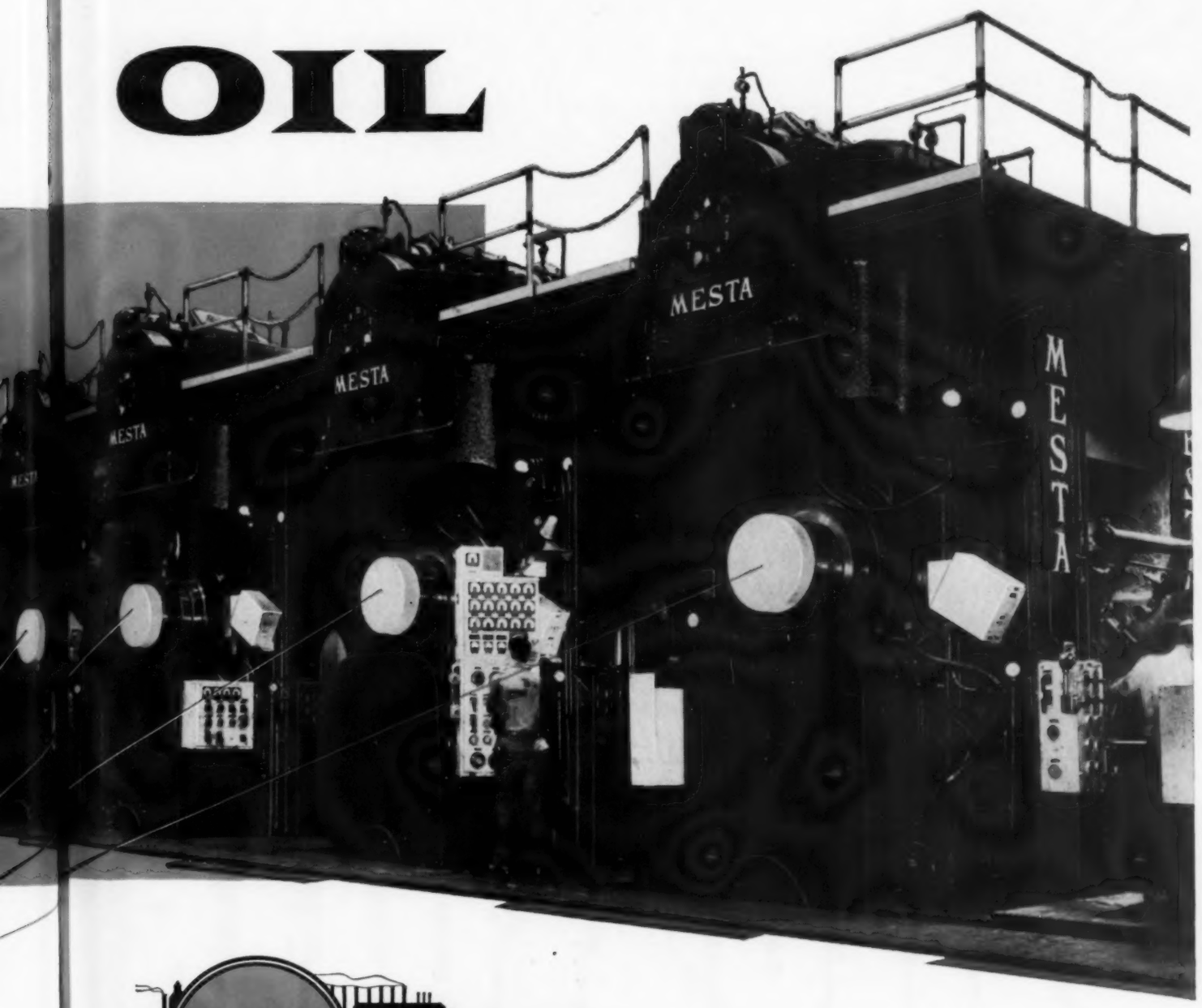
Whether your mill operates at a speed of 7000 or 700 feet per minute, make your next order for a roll bearing lubricant an order for dependable, efficient lubrication by specifying Gulf I-C Oil. Call your nearest Gulf office today and ask a Gulf Sales Engineer to recommend the proper grade for your equipment.





world's fastest cold strip mill

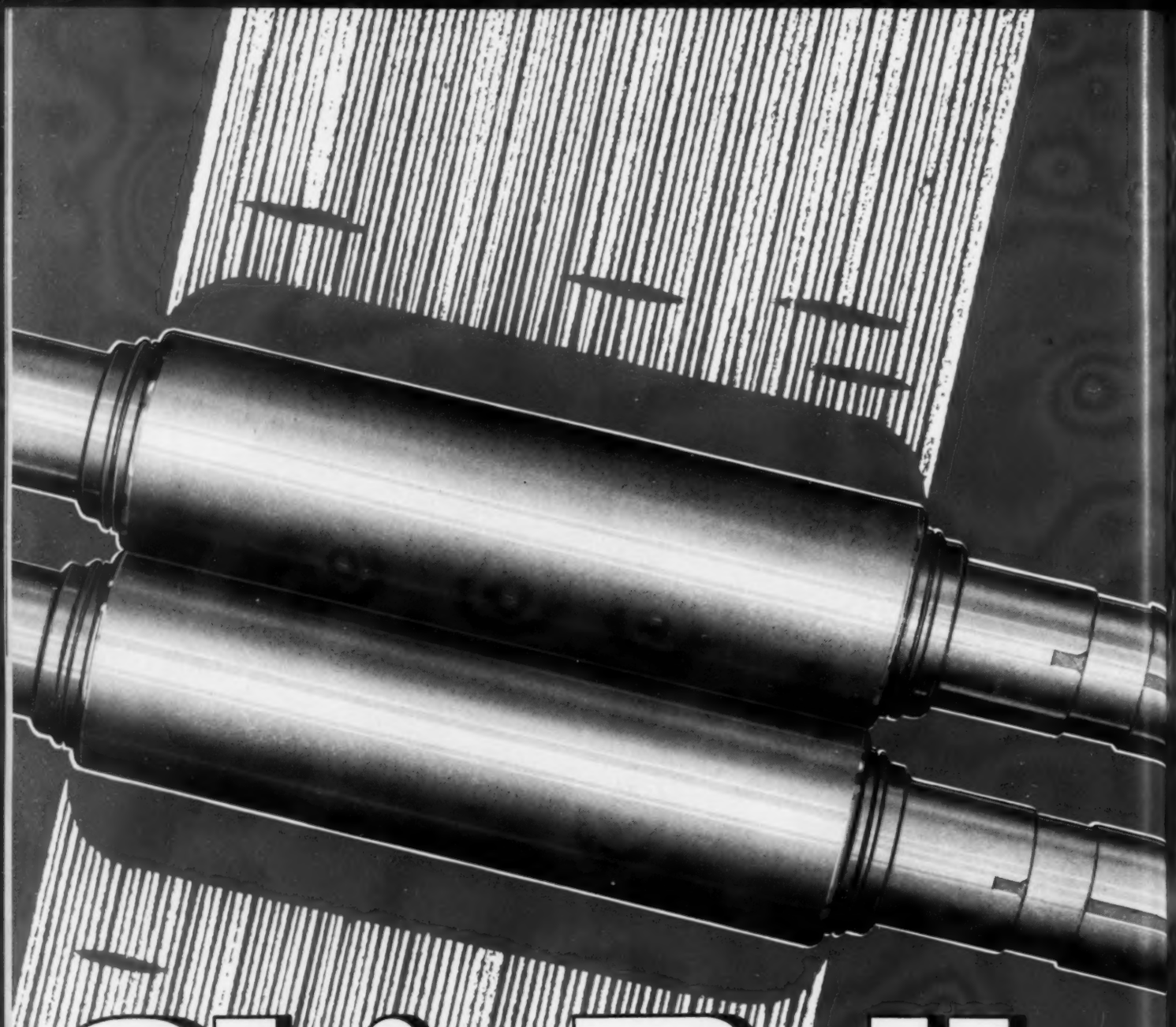
OIL



GULF INDUSTRIAL LUBRICATION

Gulf Oil Corporation · Gulf Refining Company

1822 Gulf Building, Pittsburgh 30, Pennsylvania



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HOLL-O-CAST ROLLS • CHILLED IRON ROLLS • DENSO
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NIOLOY ROLLS • FLINTUFF ROLLS • OHIO DOUBLE-POUR ROLLS

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LIMA, OHIO • Plants at Lima and Springfield, Ohio

Industry News...

SEAMLESS TUBE CAPACITY TO BE INCREASED AT REPUBLIC STEEL'S SOUTH CHICAGO WORKS

▲ Capacity of the Republic Steel Corp. South Chicago seamless tube mill will be increased by nearly 70 per cent with the addition of new facilities for rolling small size seamless tubing. This is the first project of the expanded capital expenditure program for 1954 which was announced recently.

Work already has begun on the addition, which is expected to be completed in the spring of 1955. When the new facilities are in operation, capacity of the seamless tube mill will be increased from 186,000 tons a year to 312,000 tons a year.

At capacity operations the new facilities are expected to provide 200 new jobs at Republic's South Chicago steel plant. By supplying a ready market for the plant's steel, the new facilities will further stabilize all iron and steelmaking operations at the plant. Present employment at the South Chicago works is approximately 4100.

The new facilities will produce oil country tubing in 2⅜ in. outside diameter and 2⅞ in. outside diam; bearing tubing ranging in size from 1⅞ in. through 5 in. outside diam; and pipe coupling stock for 2⅜ in. through 4½ in. tubing.

These facilities will supplement the existing seamless tube mill which was put into production early last year. The present mill can produce seamless tubular products in sizes from 2⅜ in. outside diam. through 9⅝ in. outside diam. The new facilities will be housed largely in the existing seamless tube mill.

Major equipment to be installed includes a billet heating furnace, piercing mill, plug mill and two reelers together with necessary conveyors, roll tables and electrical equipment. As with the existing seamless tube facilities, steel for the new operations will be supplied by the 36-32 in. billet mill.

Completion of the new unit will enable Republic's seamless mills to produce bearing tubing, refinery piping and other seamless tubular items in addition to the oil country tubular goods currently being made.

TAR PLANT COMPLETED AT FAIRFIELD, ALA.

▲ Construction work has been completed on the new tar plant of Tennessee Coal & Iron Division, U. S. Steel Corp. at Fairfield, Ala. The plant, which was erected on the grounds of TCI's coal chemical department will recover from crude tar such products as naphthalene, creosote oil, solvent naphtha and pitch. They will be marketed principally in the southern area.

The plant was constructed in order to supply the rapidly growing chemical industry of the south. The Fairfield facility is one of several being constructed at various manufacturing divisions of United States Steel in accordance with its recently established policy of maximum sales of coal chemicals.

While production of tar derivatives will be a TCI function, sales and distribution will be directed by United States Steel's coal chemical sales division.

Until the present, most of the tar produced as a result of the coking process has been used as fuel at the open hearth furnaces. However, the growing industrial demand for tar derivatives has made it more desirable to break the tar into its various chemical components than to use it for heating purposes.

INCREASE EXPENDITURES FOR 1954 EXPANSION

▲ Capital expenditures of $35,000,000 have been planned for 1954 by Inland Steel Co. This represents an increase of $11,000,000 over 1953 investments in new facilities, according to the company's annual report.

The expansion plans look beyond the immediate situation in which steel mills are capable of producing more steel than the market demands, heaviest outlays being for development of the company's Caland ore properties in Ontario, Canada.

Described as the biggest individual undertaking in the company's 60-year history, the Canadian ore mine is not scheduled to come into production until 1960. It is estimated to con-

CLEVELAND BLAST FURNACE UNDER CONSTRUCTION

This 229-ft-high blast furnace is being built at the Cleveland, Ohio, plant of the American Steel & Wire division of United States Steel Corp. The design and construction will incorporate the most modern equipment for preventing air and water pollution. Completion is expected by early summer.

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Red Circle Rolls for all Purposes

Hyde Park Red Circle Rolls are outstanding in quality and in performance and are easily identified by the Red Circle.

for
finer finish
long life
greater tonnage
Specify Red Circle

Chilled Rolls
Alloy Iron Rolls
Moly Rolls
Nickel Chilled Rolls
Grain Rolls
Cold Rolls
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Hyde Park
FOUNDRY & MACHINE CO.
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ROLLS
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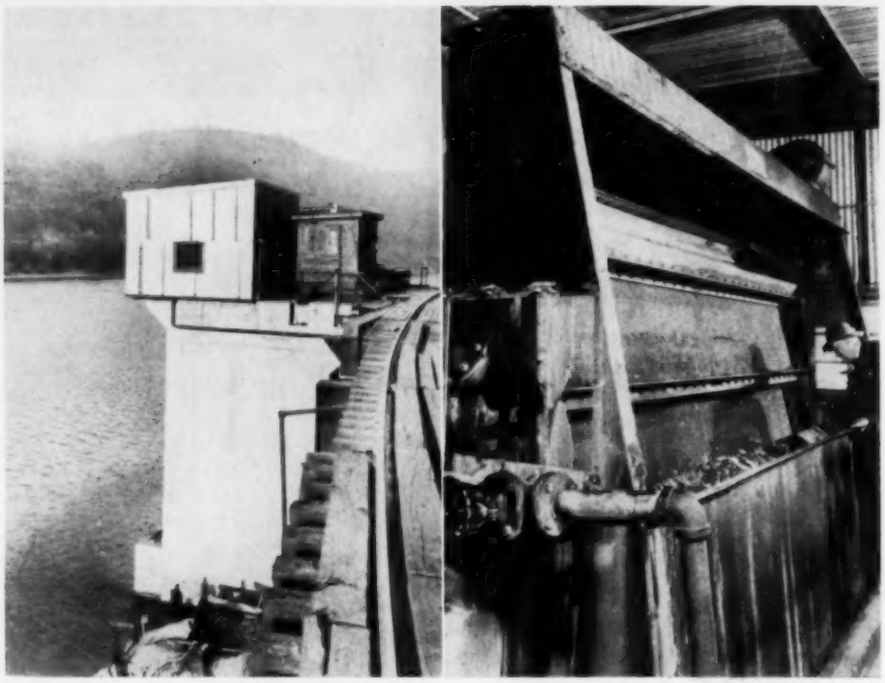
INTAKE SCREENS WATER FOR PITTSBURGH STEEL



New water intake facilities, about 60 ft long and 20 ft wide (left), built for the Monessen works of Pittsburgh Steel Co. by Dravo Corp., remove debris, leaves, logs and other refuse from some 100,000,000 gallons of water daily. Two self-cleaning vertical traveling screens (one is shown at the right) are installed in the intake house. Before the new facilities were constructed, the old pumphouse occasionally became clogged, reducing water intake. The new intake and screens provide a reliable source of water supply.

tain at least 50,000,000 tons of high grade iron ore, and is considered "protection on this prime raw material far into the future."

The year's plans also include an addition to power generating capacity at the Indiana Harbor, Ind., steel plant and construction of six new soaking pits. Completion of these facilities will provide for future plant growth, the report said, and permit better use of all facilities.

The company is also building a second continuous galvanizing line and making improvements in its cold rolled sheet and its tin plate departments.

Net income for 1953, previously reported at $33,867,184 or $6.90 a share compared with $23,755,218 or $4.85 a share in 1952 when operations were interrupted by the steel strike. This was after federal income and excess profit taxes of $39,379,000 or $8.02 a share. The net income per dollar of sales was 5.9 cents, compared with 5.2 cents in 1952. Prices were increased during the year but left steel selling at about 5½ cents a lb at the mill, which the company said made it still one of the cheapest commodities available.

Dollar sales set a record at $575,590,771 and tonnage shipments of mill products a new high at 3,707,750 tons, about 10 per cent of which went to defense purposes.

WHEELING ANNOUNCES ANNUAL CAPACITIES

▲ Annual capacities of Wheeling Steel Corp., effective January 1, 1954 increased to 1,720,000 net tons of coke; 1,800,000 net tons of pig iron; and 2,130,000 net tons of open hearth and bessemer steel ingots, according to the corporation's 34th annual report. Attainment of these capacities has placed the corporation in the position of being self-contained with respect to its requirements for coke, pig iron, and melting scrap.

During 1953, the corporation expended approximately $29,400,000 for new facilities, betterments, and improvements to its existing plants. This compares with an amount of $20,000,000 covering similar expenditures during 1952. The report shows that the following major segments of the company's post-war construction and improvement program were completed and placed in operation

Attend...
THE 1954 IRON and STEEL EXPOSITION
CLEVELAND PUBLIC AUDITORIUM, Cleveland, O.
SEPTEMBER 28, 29, 30 and OCTOBER 1
Learn...
Whether your interests are design, construction, operation or maintenance—your job requires that you *see* the latest equipment, supplies and services displayed by over 200 companies—and *hear* papers presented at the technical sessions on every phase of steel production by the industry's most outstanding authorities.
Benefit...
The benefits derived from viewing the displays, hearing the technical sessions, and the individual discussions you will have with men whose problems are similar to your own, will more than compensate for your time. Don't miss it. Join the more than 15,000 men who will attend—who know from past experience the value of this great Exposition.
REGISTRATION IS FREE!

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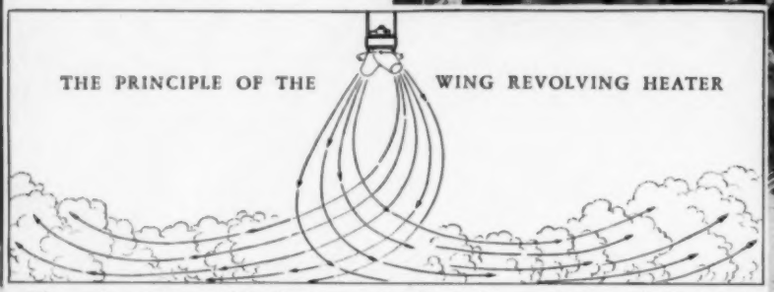
IRON and STEEL ENGINEERS

1010 EMPIRE BUILDING, PITTSBURGH 22, PENNSYLVANIA

HEAT THAT MOVES AROUND

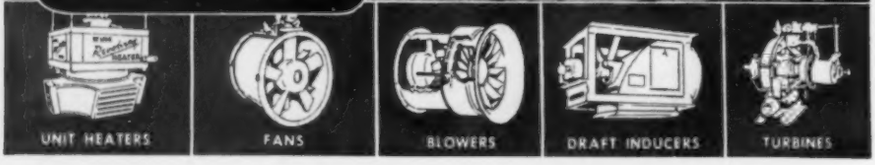
THE fact that the discharge outlets of WING Revolving Unit Heaters keep the heated air in constant, gentle motion is one of the reasons why nationally known firms like the Budd Company have installed them in their plants, both at Philadelphia and in the one shown in this photograph, at Gary, Indiana. The big blanking and forming presses in this great plant present a natural barrier to ordinary fixed discharge heating systems, but not to the moving streams of heated air from the WING Revolving Heaters, even suspended, as they must be, far above the floor, to clear the cranes. That is equally true in the summer time when, with steam turned off, the cooling breezes from the revolving discharge outlets keep workers comfortable on the hottest days. Investigate. Write for Bulletin HR-6.



The moving streams of heated air (or cooling breezes in summer) sweep slowly around through 360 degrees, covering successively every direction. The air velocity is sufficient to carry to walls, and remote corners and the constantly changing direction of flow causes the air to find its way around obstructions.

Wing

L. J. Wing Mfg. Co.
142 Vreeland Mills Road
Linden, New Jersey
Factories: Linden, N. J. and Montreal, Can.
In Europe: Etab. WANSON, Brussels, Belgium



during the latter part of 1953: (1) improvements and reconditioning of the bessemer plant, construction of new soaking pits, and the purchase and erection of a 44-in. blooming mill and auxiliary equipment at Steubenville-South works, resulting in the discontinuance of production of bessemer ingots at the Benwood plant; (2) improvements to 12 in. skelp mill to permit the rolling of heavier billets at the Benwood plant; (3) purchase and installation of a new continuous galvanizing line at the Martins Ferry plant; (4) installation of side trimmers on continuous pickle-lines at the Yorkville plant; and (5) the installation of a new coal washing plant at Harmar mine of Harmar Coal Co., a subsidiary.

Completion of the new continuous galvanizing line at Martins Ferry marked another milestone for the corporation.

ANNOUNCE JOINT ORE UPGRADING PROJECT

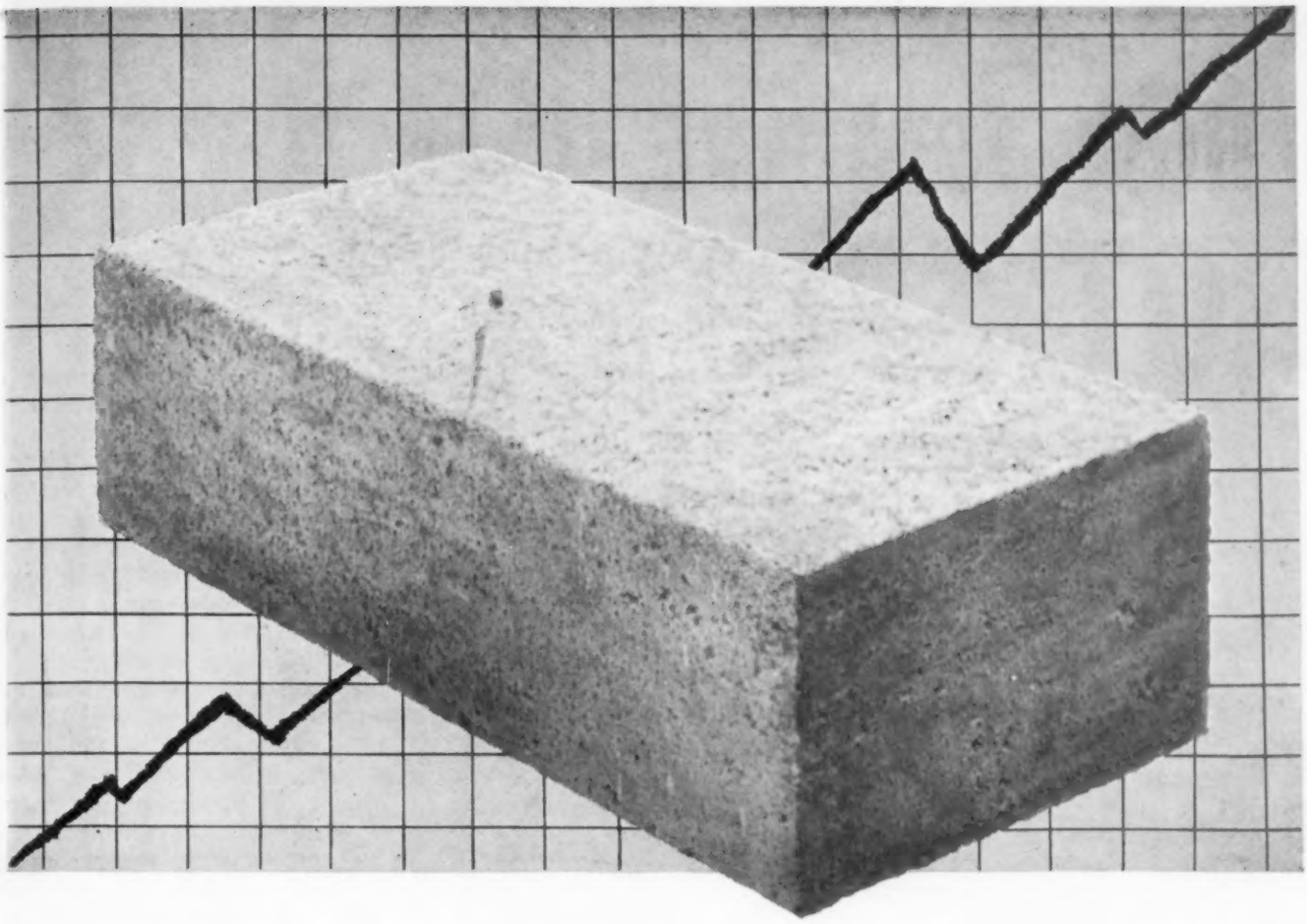
▲ Announcement of a joint project to upgrade southern iron ore and iron-bearing materials was made by Republic Steel Corp. and National Lead Co.

Success of the project would result not only in the upgrading of ore now usable, but also in the utilization of mineral resources which are now of little economic value and have heretofore not been usable by the steel industry.

A large scale pilot plant is now under construction at Republic's Spaulding iron ore mine near Birmingham, Ala., where production scale studies of the contemplated upgrading project will be made. The pilot plant will be completed and in operation this summer. The iron ore concentrate to be produced is expected to be sufficiently upgraded to warrant its use in modern blast furnaces.

The joint project combines the broad experience of both companies in closely related fields. The extensive experience of National Lead in the treatment of non-ferrous ores supplemented by its extensive research in Norway during the past eight years is matched by Republic's experience with southern iron ore as well as in the beneficiation and use of low iron content southern non-magnetic materials.

Spokesmen for the two companies point out that, though there are still



INCREASE YOUR OPEN HEARTH BOTTOM LIFE

WITH PERMANENTE PERICLASE BRICK!

WITH Permanente Periclase "D" burned brick as the subhearth under a Permanente 165 bottom you get *higher MgO per unit volume than possible with any other refractories available today.*

Permanente Periclase "D" bricks provide 9.43 lbs. of MgO per 9" equivalent, plus *maximum* density with absence of connected voids. Used in combination with Permanente 165 you are sure of the ultimate in bottom safety and durability.

Write for descriptive literature on (1) Permanente Refractory Brick, (2) Permanente 165, and (3) the companion ramming mix, Permanente 84.

Principal sales office: Chemical Division, Kaiser Aluminum & Chemical Sales, Inc., First National Tower, Akron 8, Ohio.

Permanente Periclase Brick for the Steel Industry:

PD-B (Periclase "D" burned) brick for open hearth and electric furnace bottoms. Low in iron, lime and silica. Chrome free. Maximum MgO in bottom.

PCA, PCA-MC (Periclase-Chrome "A"), plain and metal-encased for open hearth end walls, front walls and uptakes. Metal-encased for electric furnace sidewalls. High in MgO. Outstanding all-purpose refractory.

CPA-B (Chrome-Periclase"A," burned) for open hearth front and back walls. Controlled chrome additives result in highest resistance to spalling.

CPA-MC (Chrome-Periclase "A"), metal-encased for open hearth back walls, front walls. **D** (Chrome "D" burned) for open hearth bottoms, soaking pits. High hot load strength.

Installation advice on request

Kaiser Chemicals

Producers of the most complete line of basic refractories

BASIC REFRACTORY BRICK AND RAMMING MATERIALS • CASTABLES AND MORTARS • MAGNESITE • PERICLASE • DEADBURNED DOLOMITE

HOW TO SOLVE HOT SPOTS

(UP TO 2200° F)

in products and processes

If improvement of your product or process depends upon use of extremely high temperature, while minimizing its destructive effects, use Kentanium at the critical points.

WHAT is Kentanium?

Chiefly titanium carbide (and small percentages of other refractory metal carbides), with nickel "binder". Uses neither tungsten nor cobalt. Hardness: Up to 93 RA. Weight: ⅔ that of steel.

WHAT can it do?

Resist thermal shock, withstand oxidation and abrasion, retain great strength at high temperatures (1800°F and above).

WHERE is it in use?

Successful applications include: Valves, valve seats, reduction crucibles, anvils for spot welding, hot extrusion die inserts, bushings, thermocouple protection tubes, flame tubes, furnace tong tips, balls for hot hardness testing, nozzle vanes and blades for jet engines, and many others.

WHAT forms are made?

Tubes, rods, bars, flats by extrusion process. More complex parts by machining from pressed slugs before sintering; extremely accurate parts by grinding to required tolerance after furnace sintering.

HOW can you use it?

This remarkable new metal, available in many "grades" to meet specific combinations of imposed conditions, can best be adapted to your high temperature problem by cooperative effort. Our engineers will be glad to discuss how you can get best results from Kentanium.

An Exclusive Development of KENNAMETAL® Inc., Latrobe, Pa.

KENTANIUM

HEAT-RESISTANT, HIGH-STRENGTH, LIGHTWEIGHT CEMENTED TITANIUM CARBIDE

deposits containing millions of tons of high grade iron ore in the United States, these deposits are being rapidly depleted.

The steel industry is partly meeting this situation in the north in three ways: First, through the program for beneficiating Minnesota magnetic taconite; the magnetic taconite deposits are vast but fall far short of non-magnetic ore resources. Secondly, by the development of iron ore fields in the Quebec-Labrador wilderness. Thirdly, by importations of ore from abroad in sharply increasing tonnages making the American steel industry increasingly dependent on overseas mines for its iron ore.

However, the nation's reserves of low grade non-magnetic iron ores and other materials too lean to be considered as ores today run into the billions of tons. Very little of this has been touched.

A method of upgrading these non-magnetic ores, found not only in the south but in many other parts of the country, will materially assist in extending the usable iron ore reserves of the United States for many years.

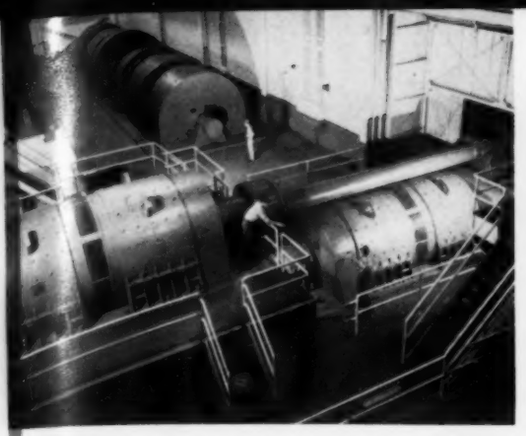
There are large tonnages of such materials available in the south. They include the ferruginous sandstone of Ala., the familiar Ga. ochre and similar materials in Tenn., N. C., Va. and many other states.

According to the United States Bureau of Mines reserves of ferruginous sandstone in the Birmingham basin alone exceed 1,000,000,000 tons with iron content running from 23 to 27 per cent. The production life of commercial ore from operating mines in the basin is estimated by the Bureau of Mines at 41 years under today's economic conditions. The Bureau believes, however, that by the addition of commercial ore from all other sources, marginal ore and the ferruginous sandstone reserves, the production life of iron minerals in the Birmingham basin may be extended to 235 years.

J&L BLOOMING MILL HOLDS INGOT RECORD

▲ Holder of the world's ingot record, the Jones and Laughlin Steel Corp.'s 44-in. blooming mill at Aliquippa, Pa., has twice smashed its old mark since it was converted from steam to electric drive last fall.

On the January 3 night-shift the mill rolled a new high of 576 ingots,



Shown is the electric drive equipment for the 44-in. blooming mill of the Jones & Laughlin Steel Corp., Aliquippa, Pa., plant. In the foreground is the 12,000-hp double armature twin motor. Each of the four armatures are rated: 3000-hp, 70/140-rpm, 750-volt d-c. In the background is the flywheel motor generator which consists of four 3000-kw, 750-volt d-c generators, one 9000-hp, 6600-volt, 3-phase, 60-cycle induction motor and one 250,000-hp second flywheel at 360-rpm.

producing 2534 tons (sheared.) This betters two former records—522 ingots rolled on the old steam-driven mill in 1949, and 538 ingots turned out on the new electrified mill last December.

The main drive of the "title-holder" is made up of four G-E 3,000-hp motors powered by four 3,000-kw generators. A pair of motors, in tandem, drives each of the two mill rolls. The new drive can change from 70 rpm in one direction to 70 rpm in the other in less than one second. Motors and generators are enclosed for downdraft ventilation.

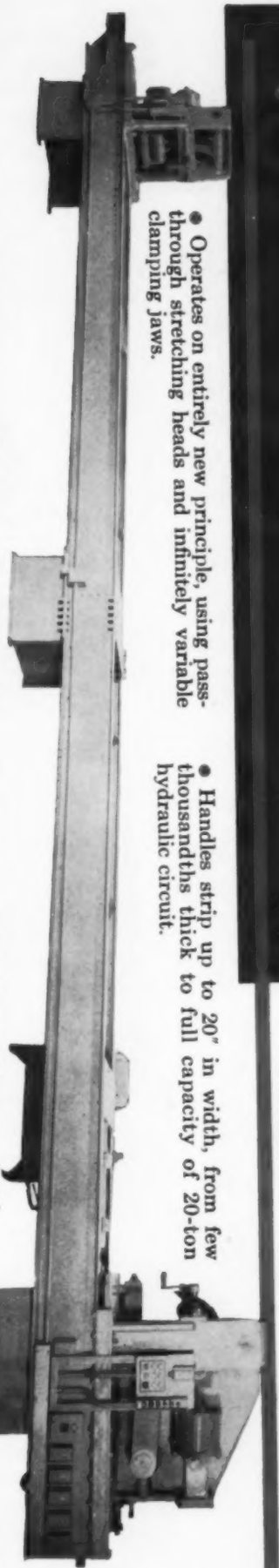
In setting the new eight-hour turn record the J & L mill averaged 72 five-ton ingots per hour with a high of 76 ingots in one hour. It also holds the world's record for the number of ingots rolled in a week and a month.

The "champ" steam engine was retired last September 8 after 41 years service. On September 15, more than two days ahead of schedule, the new G-E 12,000-hp drive went into operation.

To minimize production downtime during conversion, all electric equipment, including switchgear, motor-generator sets, ventilating equipment, exciter sets, and control, were installed and tested on the site before the steam engine was shut down. The new mill drive was completed and assembled on a temporary foundation outdoors to assure that all

Automatically Straighten Coiled Strip, Up To 20" Wide, Any Thickness!

MEDART STRIP STRAIGHTENER



- Operates on entirely new principle, using pass-through stretching heads and infinitely variable clamping jaws.
- Handles strip up to 20" in width, from few thousandths thick to full capacity of 20-ton hydraulic circuit.
- Push-button controlled automatic cycle starts strip from coil, stretch-straightens it under automatically controlled percentage of stretch, releases and recoils it at speeds exceeding 350 fpm. Machine returns to starting cycle without attention from operator.
- Removes camber. Improves temper of strip.
- Straightens up to 4 narrow strips simultaneously.
- May be operated with slitter, and can be equipped with special shear to cut straightened strips to any length.

Model SL20-20-40

Write For Details

THE MEDART COMPANY • 3535 DE KALB STREET • SAINT LOUIS 18, MO.

HERE'S THE U.S.G.® BRUSH THAT DOES AN OUTSTANDING JOB ON ALL YOUR MILL MOTORS

When you replace the brushes on your mill motors, you can get the best results with U.S.G. Grade 135 Brush with Statite®. For brushes that give superb results in other applications, see below. Write for your copy of the complete U.S.G. Brush catalog today.

A typical U.S.G. 135 Mill Motor Brush with Statite*

U.S.G. Grade 1658 Brush for tin line collector rolls

U.S.G. Grade 223 Brush for DC crane motors with Statite*

U.S.G. Grade AH897 Brush for welding generators with Statite*

U.S.G. Grade 550 for AC Crane Motor Rings

Permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

189

OUR 100th YEAR

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

couplings, conduits, pipes, and other fittings would fall neatly into place. Hundreds of men were trained in the various steps of the change-over operation before the shutdown. Forty-six yards of concrete had to be removed from the foundation of the steam engine and as much of this as possible was accomplished ahead of time.

CLEVELAND DISTRICT OFFICE OPENED BY JOY

▲ Joy Manufacturing Co. has announced the opening of a new district office at Cleveland, Ohio for more convenient sales and service in the Ohio-Michigan area.

Howard E. Butters, formerly district manager in St. Louis, Mo., has been appointed district manager at the new Cleveland office with headquarters at 2410 Terminal Tower.

ANNOUNCE FORMATION OF R. M. REICHL CO.

▲ Formation of the R. M. Reichl Co., specializing in development-engineering, process-development and consulting, with offices at 110-11 Seventieth Road, Forest Hills, Long Island, N. Y., is announced. The new company has been organized by Mr. R. M. Reichl, who has been active in the field of heavy presses, extrusion, hydraulic machinery, pipe mills and rolling mills for over 20 years. Mr. Reichl is a former vice president of Hydropress, Inc.

TO BREAK GROUND FOR METALS PLANT

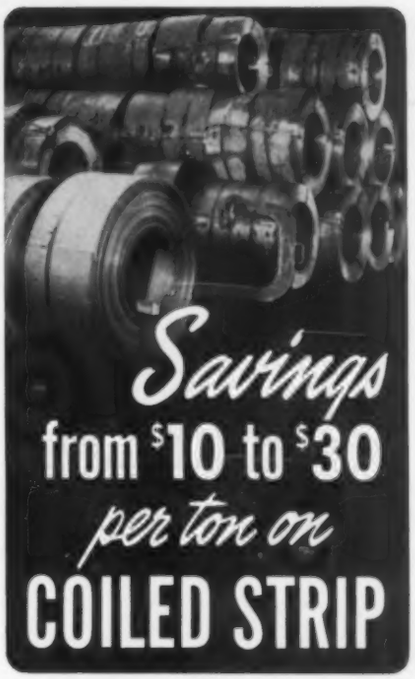
▲ Ground will be broken in May for construction of the Westinghouse Electric Corp.'s multi-million-dollar metals plant at Blairsville, Pa. The main building exterior should be completed by the end of this year and most of the machinery and equipment installed and operating by mid-1955, it was reported.

The main purpose of the new metals plant will be to bridge the gap between research and the commercial application of metals in the electrical industry.

This plant will provide equipment for the basic metal working processes of melting, forging, hot-rolling, cold-rolling, conditioning, pickling and heat-treating. In addition, facilities for the newer foundry techniques of investment casting and shell-mold

JET TORCH PROCESS REPLACES CHIPPING GUN

A great variety of steel castings are cleaned by the jet torch process at the casting division foundry, American Chain & Cable Co., Reading, Pa. Castings are deposited outside the jet torch booths in left foreground by an electric magnet, then wheeled inside on one of the small flatcars. The jet torch process has replaced the pneumatic chipping gun in 75 per cent of the foundry's cleaning operations.



usually pay for the installation of a Yoder Slitter in a year, more or less, where monthly requirements in slit strands are upwards of 100 tons.

Of even greater importance to metal fabricators doing their own slitting, is the fact that they can buy standard width coils competitively, wherever they can obtain the best price and delivery, while otherwise they are often limited to the few sources able to supply slit-to-width strands.

Changes in production schedules can also be more readily made, and strip inventories greatly reduced because expected and unexpected needs can be met on a few hours' notice from a relatively small stock of standard width coils.

The economics as well as the mechanics of Slitter operation are fully discussed in the Yoder Slitter Book . . . yours for the asking.

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— Safety
— Economy
— Dependability
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the only complete line of
ALLOY STEEL CHAIN
because...

● Taylor Made Alloy Steel Chain has twice the tensile strength (125,000 lbs. P.S.I.) of wrought iron chain (48,000 lbs. P.S.I.)!

● This famous nationally advertised chain is heat-treated—never requires annealing!

● It has tremendous resistance to shock, grain-growth and work-hardness at all temperatures!

● All slings are furnished with amazing new Taylor Made Alloy Steel Tayco Hooks!

● Rings, joiner links and other sling attachments are of the same analysis, heat-treated alloy steel as the chain.

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Rush free copy of Booklet No. 12C giving all the facts and specifications on Taylor Made Alloy Steel Chain!

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A GREAT NAME IN
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casting will be installed. Also provided will be equipment for limited maufacture of powder metal parts.

MELLON-STUART FORMS OPERATING SUBSIDIARY

▲ Mellon-Stuart Co. announced that it has formed a new operating subsidiary, the Mellon-Stuart Industrial Construction Co., to specialize in engineering and construction in the heavy industrial field.

Formation of the subsidiary marks Mellon-Stuart's first departure from the general construction field.

The new company will concentrate on the relining, rebuilding and modernization of blast furnaces and accessory equipment; rebuilding of coke ovens; design and construction of raw material preparation facilities and general construction services to the steel and related industries.

R. L. Clark, former staff engineer in charge of blast furnaces and coke ovens for the Jones & Laughlin Steel Corp., has been named general manager of the new firm.

Before moving to J & L's main office in Pittsburgh, he was in charge of blast furnace, coke oven and open hearth engineering for the company's Cleveland works. Mr. Clark also worked with John Mohr & Sons as an engineer, and in sales of blast furnace, plants and ore preparation facilities, with A. J. Boynton & Co. as blast furnace engineer in the rehabilitation of the Mingo Junction plant of the Wheeling Steel Corp., and as engineer in charge of construction of blast furnace equipment for William M. Bailey Co.

WEST COAST OFFICE OPENED BY DRAVO

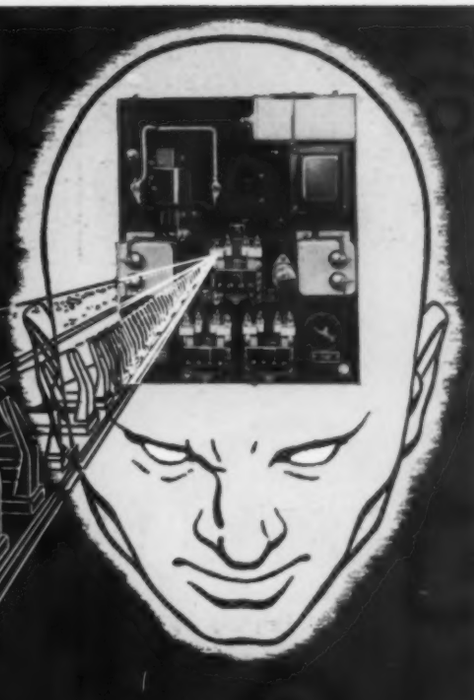
▲ The opening of a West Coast office in the Monadnock Building, 681 Market St., San Francisco, Calif., has been announced by Dravo Corp.

In addition to Dravo's complete line of oil and gas fired industrial space heaters and process drying equipment, with unit capacities ranging from 88,000 to 2,000,000 Btu per hour, the new office will handle the sale of crane cab and steel mill pulpit air conditioning equipment; prefabricated power and process piping; open steel flooring and construction services.

The office which will be managed

Electronic Brain

CONTROLS WORLD'S LONGEST SINGLE-FLIGHT CONVEYOR BELT!*



*11,000 foot rubber belt in mile-long conveyor handles coke between coking plant and blast furnaces at large eastern steel mill.

In this installation, the NEO-TIME-CURRENT ELECTRONIC ACCELERATOR (in white circle) is shown on an EC&M 150 h.p. 440-volt starter.

EC&M AUTOMATIC ACCELERATOR MODIFIES TIME BY MOTOR CURRENT TO COMPENSATE FOR LOAD AND WEATHER CONDITIONS

THE EC&M NEO-TIME-CURRENT METHOD OF ACCELERATION is not just time limit or current limit . . . it actually combines the advantages of both to give positive acceleration modified by load conditions. As its name implies, it is inherently self-adjusting and automatically provides for (1) fast acceleration of an empty belt on a hot day and (2) slow acceleration of a loaded belt under icy conditions.

NEO-TIME-CURRENT STARTER FEATURES:

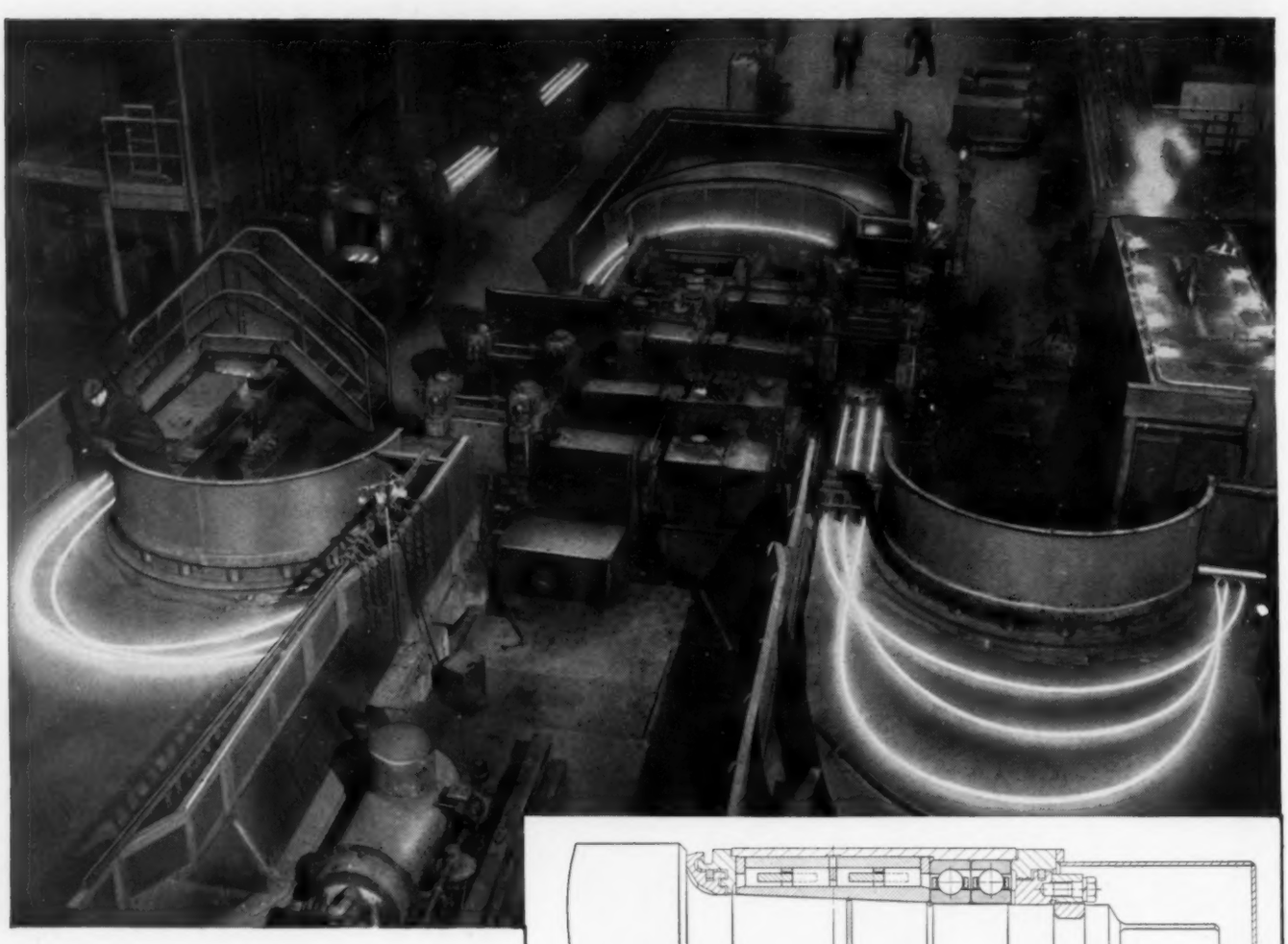
1. It permits use of single motor-drive on long conveyors.
2. Belt stretching is controlled within safe limits during acceleration.
3. Convenient adjusting dials can be set for slow start during break-in period and then gradually changed to give most efficient acceleration for best operation.
4. After tune-up, further manual adjustment is eliminated by automatic self-adjusting characteristic of the Neo-Time-Current.

For Details and Specifications, Write Today for Booklet 1041.

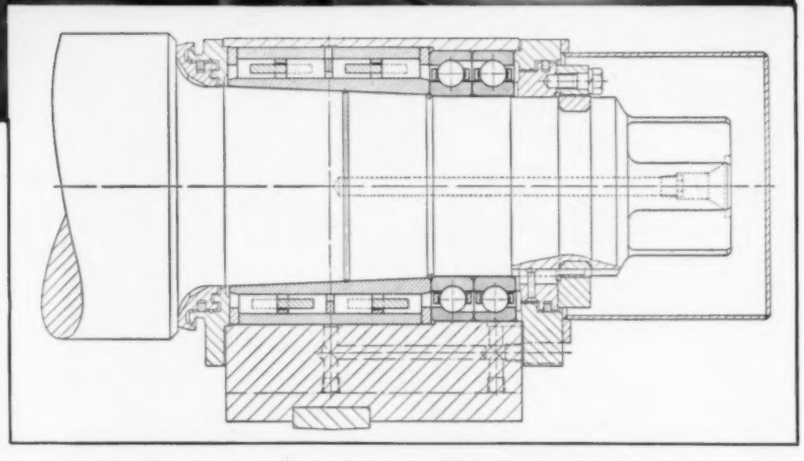
E&M

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO



top quality rod
at better than
50 miles per hour



SKF Roll Neck as installed in United's Rendleman Mill at Jones & Laughlin. Dotted lines show oil passages for quick, easy bearing removal by the SKF-pioneered Hydraulic Removal System.

SKF multi-row cylindrical bearings installed on the roll necks of the Jones & Laughlin Rendleman rod mill by United Engineering and Foundry Company, are doing an outstanding job at mill speeds of 4700 feet per minute.

The SKF multi-row cylindrical bearing was specifically designed for roll neck applications. This four row grease lubricated bearing incorporates all those necessary qualities for the highest standards of roll neck bearing performance long desired by mill builders.

This is another example of SKF leadership in the rolling mill field. Consult SKF and have *them* help *you* "put the right bearing in the right place."

SKF INDUSTRIES, INC., Philadelphia 32, Pa.—*manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

7401

SKF®
BALL AND ROLLER BEARINGS

by William A. Walton, will also represent Walker Process Equipment, Inc., manufacturers of water, sewage and industrial waste treating systems.

KAISER STEEL ACQUIRES INTEREST IN DRUM CO.

▲ Purchase of approximately one-third of the common stock of the Myers Drum Co. by Kaiser Steel Corp. has been announced.

Myers Drum Co., a California corporation, was organized in 1946. In 1949 the plant began production of steel drums, and in July, 1951 began the production of pails. The company manufactures steel drums, primarily 55-gallon capacity and 30-gallon capacity, and pails ranging in capacity from 3 to 6½ gallons.

The Myers plant, with general offices in Oakland, Calif., is located on a 16-acre site in San Pablo, Calif., and is one of the major producers of steel drums and pails on the Pacific Coast, serving the petroleum industry, as well as the food, chemical and paint industries. The plant has a daily production capacity of 4000 drums and 10,000 pails. There are more than 100 employees engaged in the manufacture of these products.

WARREN BLAST FURNACE SETS REPUBLIC RECORD

▲ The Warren, Ohio, blast furnace of Republic Steel Corp. set an all-time company record for annual pig iron production during 1953. The furnace produced 574,028 tons of iron, which ranks it among the top producing furnaces of the country.

Average daily production in 1953 was 1,573 tons, well above the furnace's rated capacity of 1470 tons a day.

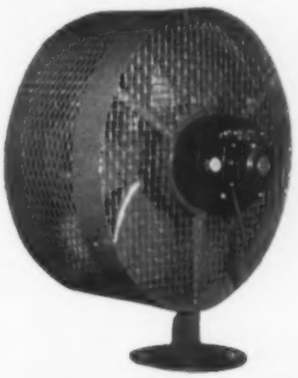
The previous Republic production record of 500,366 tons was set by the company's No. 5 blast furnace in Cleveland in 1951. Prior to that the Warren furnace production of 499,-180 tons in 1947 was the company record.

Built shortly after World War I, the Warren furnace has been enlarged three times. The latest, in 1952, increased its hearth diameter to 28 ft. In 1948 the big furnace was converted to high top pressure blowing, a revolutionary technique pioneered by Republic, which increases iron output by as much as 15 per cent.

FISH BELLY FOR BRIDGE

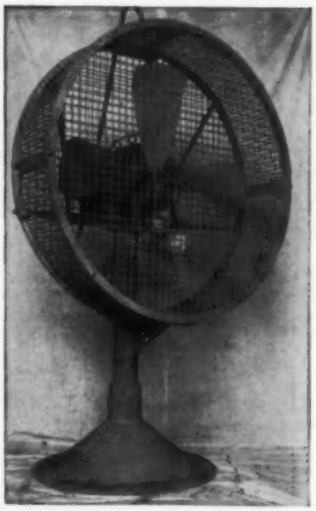
This 57-ton girder swings in a swimming position in the shops of U. S. Steel's American Bridge Division at Ambridge, Pa. Eight of these members will help to support twin bridges at Montezuma, N. Y. The structures will carry New York State Thruway traffic across the Seneca River. Four of the girders have been erected on the site by American Bridge.

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

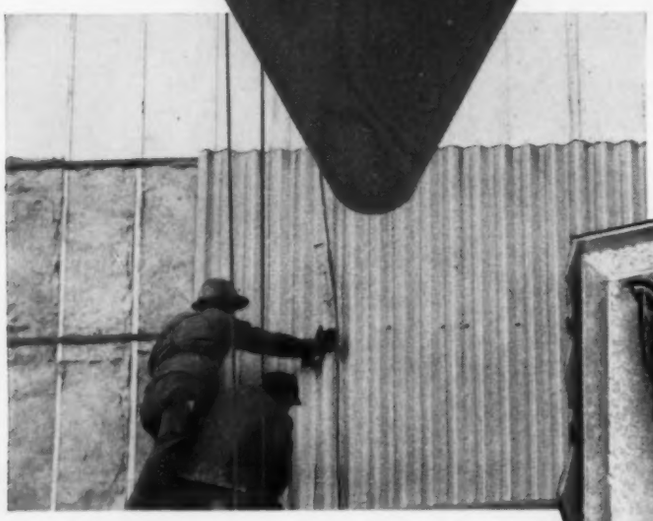
All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

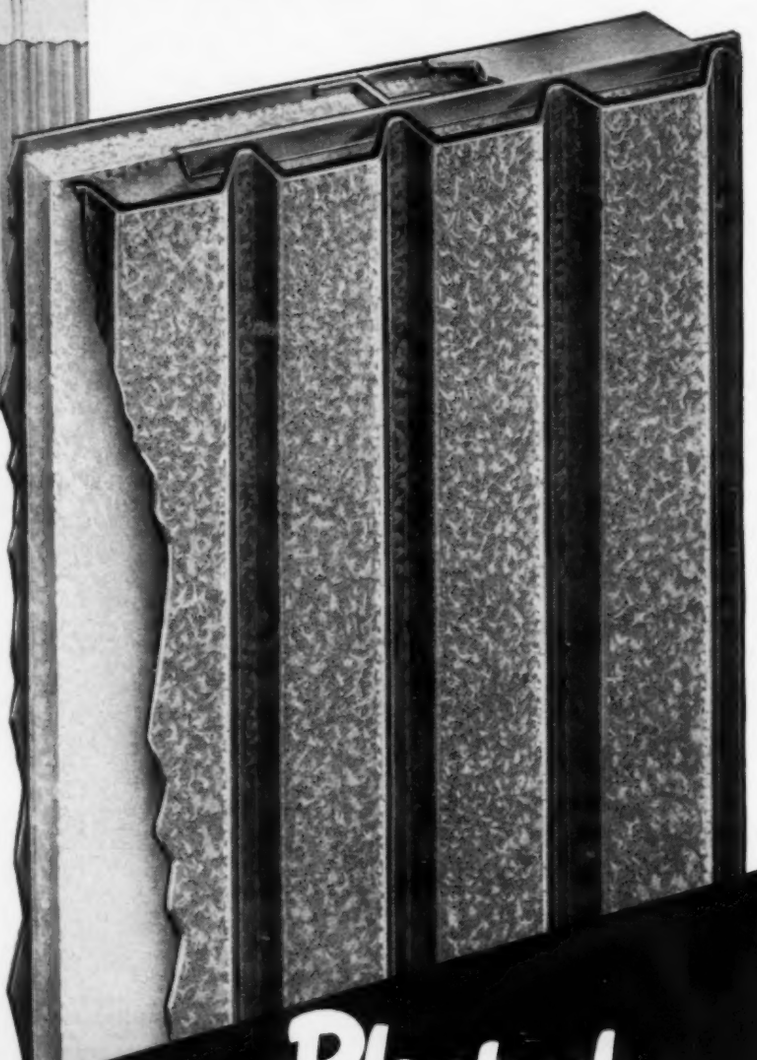
PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST. HARMONY, PA.

This building is
LIFE
conditioned with **Plasteel**

PROTECTED METAL
INSULATED PANELS





No other insulated panel can give you the protection and thermal properties of LIFE-conditioned Plasteel. Panels available in lengths up to 25 feet for field assembly—with interior wall-sheets of steel, a layer of glass fibre insulation and exterior wall of protected metal with Mica coating. Plasteel cuts heat loss, prevents harmful effects from condensation and effectively insulates against outside heat in summer. Result: closer temperature and humidity control.

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MICA makes the difference.

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☐ *Please send new Engineer's Handbook.*

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Contact your nearest Plasteel representative before you specify your next Insulated Panels—Roof Deck—Roofing or Siding. Or, mail coupon for details.

ROLLS FIRST SHEET FROM NEW COLD MILL

▲ Rolling of the first sheet steel from its new four-stand tandem cold rolling mill at Allenport, Pa., has been announced by Pittsburgh Steel Co.

Start of the new mill marks the entry of Pittsburgh Steel into the market for cold rolled sheets for the first time in its 54-year history. The sheets produced on the mill will range from 20 to 60 in. wide, and from 12 to 28 gage in thickness.

This fills out the company's line of flat rolled products to include a broad range of sizes and grades in heavy hot rolled sheets, cold rolled sheets and strip steel specialties produced at the Thomas Strip Division, Warren, Ohio. The expansion into flat rolled products in addition to the company's traditional output of wire and wire products, and seamless tubular products has been accomplished under a four-year $65,000,000 Program of Progress.

PHILADELPHIA COMPANY NAMED CARBOLOY AGENT

▲ Alden Supply Co., Inc., Philadelphia, Pa., has been named an authorized distributor for Carboloy department of General Electric Co., Detroit, Mich.

The organization will carry the department's entire line of standard cemented carbide tools and blanks, carbide-tipped masonry drills and diamond wheel dressers.

REPUBLIC APPOINTS ITALIAN DISTRIBUTOR

▲ Republic Steel Corp. and Fiat of Turin, Italy, have reached an agreement under which the Italian company will produce Republic's Enduro stainless steels and heat resisting steels in all grades at its plant in Turin for distribution in Italy.

Republic will provide engineering and technical talent to assist in laying out and installing the steelmaking facilities together with metallurgical engineers and rolling mill personnel as may be necessary to provide technical assistance during the life of the agreement.

The Enduro stainless steel made by Fiat will be sold exclusively by Republic's present Italian distributor, Cofermet, S.P.A., of Milan.

Small

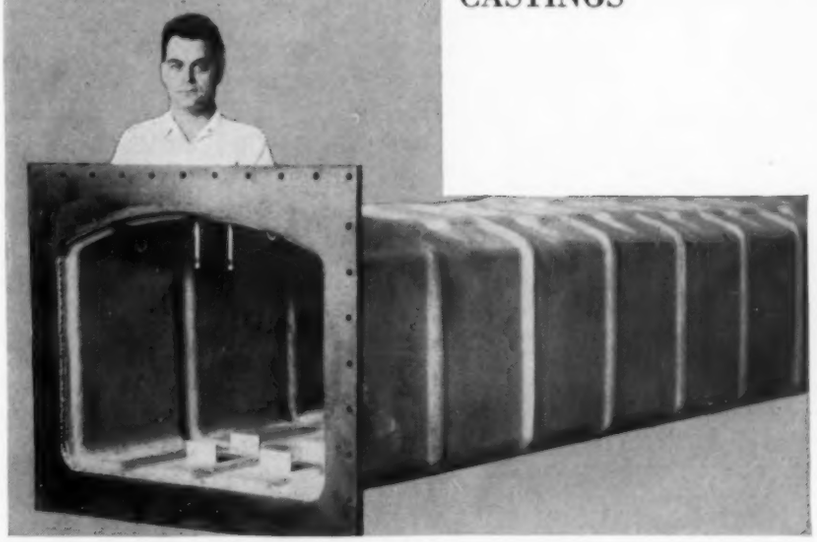
HIGH ALLOY CASTINGS

Carburizing Fixture for Ball Bearings 1½" diameter— Analysis 35% Ni — 15% Cr

DURALOY

Large

HIGH ALLOY CASTINGS



Muffle for Continuous Strip Annealing 12' 6" long — Analysis 38% Ni — 18% Cr.

LARGE or small DURALOY, can do it! These are just typical examples of the work moving through our foundry. Some of these castings are designed for heat resistance, some for corrosion resistance, some for abrasion resistance; all are cast by experienced foundrymen. All are carefully tested in our up-to-date laboratory.

If you have a high alloy casting problem . . . LARGE or small, we can help you. For more information, send for Bulletin No. 4-DU-8.

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The many critical factors in the preparation of a roll mold require a sharpness of eye and an accuracy of workmanship gained only through long experience. John Premozic's years of experience total 35, all of which were spent on the molding floor. He qualifies as an expert.

how quality is built into LEWIS ROLLS

Make one slip in gating, John Premozic, and a heat is scrapped and hundreds of man-hours wasted . . . for in this one seemingly simple task lies the success of this roll.

The pattern must be placed in precisely the right spot in the flask. The sand must be rammed around it tightly and dried thoroughly. The finished gate must be fitted carefully into place in the drag and properly aligned with the neck . . . all of these to assure one thing—the proper swirling action of the metal as it enters the mold.

This swirling, centrifugal action removes foreign material from the roll surface so that the wear-resisting alloy iron may provide a maximum of useful life in the mill.

The right sizes and types of sectional chills* must be selected to allow for shrinkage and just enough excess stock to permit minimum removal of the prime surface metal during machining.

These are but a few of critical factors involved in the molding of a Lewis Roll that deserve and receive the expert attention of men like John Premozic, whose 35 years of experience, combined with the most modern research and production techniques, assures the quality for which Lewis has been known for over 95 years. When you buy, be sure to specify Lewis Rolls. They cost you less in the long run.

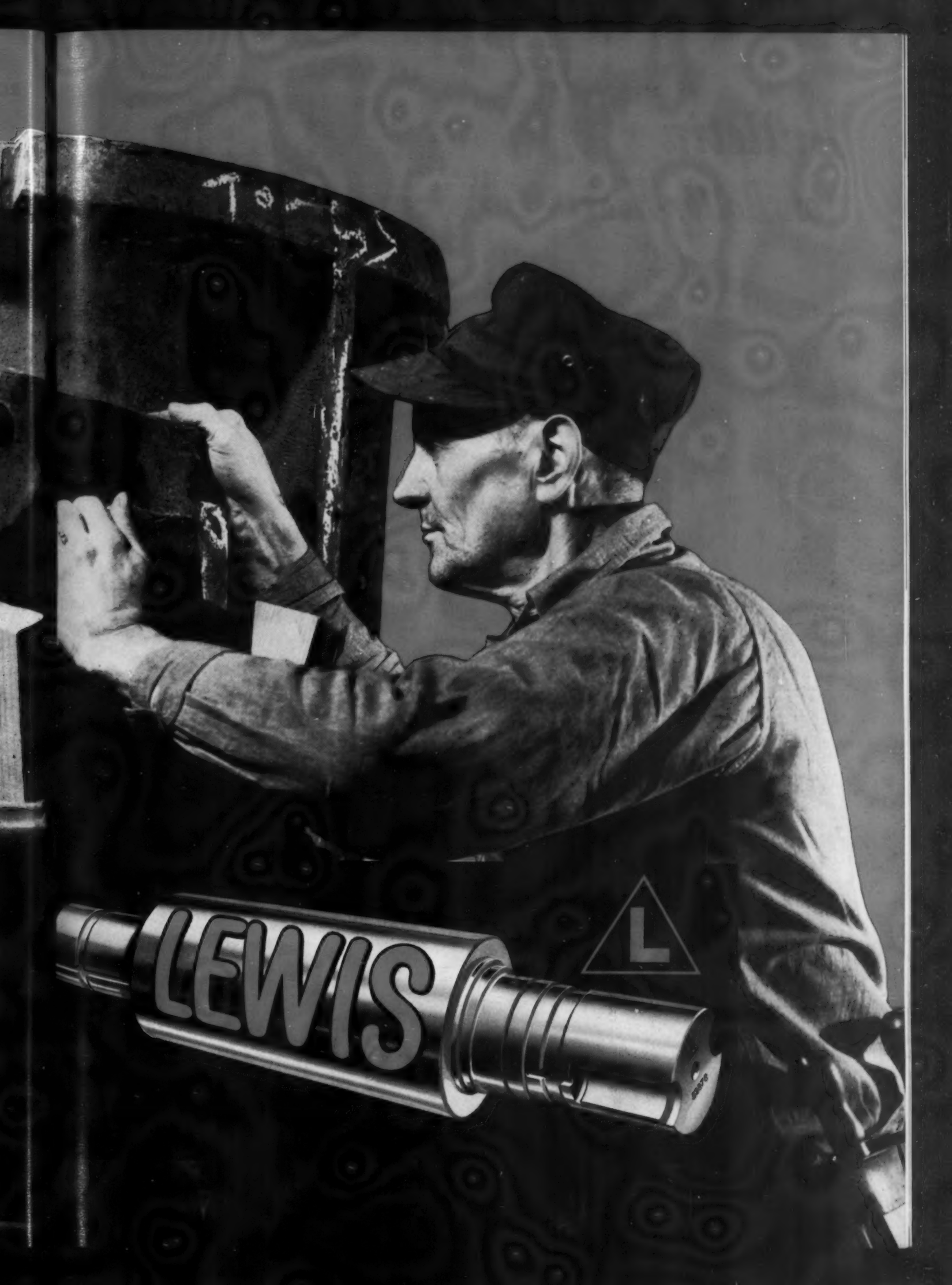
*Sawcut, sectional chills, used exclusively for Lewis Rolls, assure a greater thickness of prime, wear-resistant surface metal.

OVER 95 YEARS OF ROLL MAKING—Superior "X" Rolls—Ajax Duplex Rolls—Lewis "X" and "XA" Rolls—Special Process Rolls—Climax and Ajax Rolls—Plain Chilled Rolls—Special Tube Mill Rolls—Atlas, Atlas "B" and Atlas "X" Rolls—Molybdenum Chilled Iron Rolls

LEWIS ROLLS

BLAW-KNOX

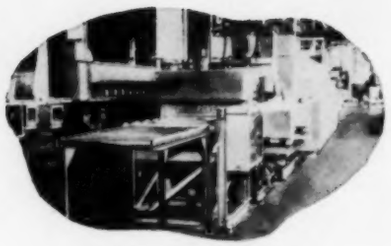
BLAW-KNOX COMPANY • ROLLS DIVISION
LEWIS ROLLS DEPARTMENT • PITTSBURGH 1, PA.


LEWIS
L

Bulletin B-90

...on Roller-Hearth Furnaces

is ready for you



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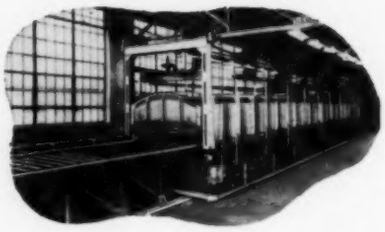

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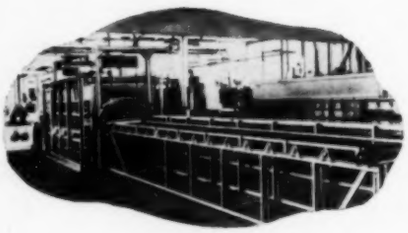

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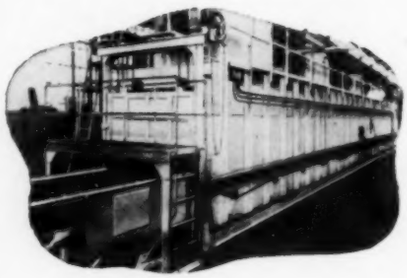

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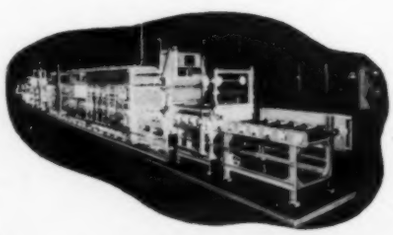

sintering

This NEW bulletin describes Drever Furnaces for many applications and Atmosphere Generators as applied to Roller-Hearth Furnaces. Our experienced engineering staff will assist you in your particular problem.

DREVER CO.

730 E. VENANGO STREET •, PHILADELPHIA 34, PA.

5

P-G Limit Switch *Resistors* . . . . . .

for use with . . .

CRANE HOIST SAFETY LIMIT STOPS!

P-G Limit Switch Resistors are available for use with any crane hoist safety limit switch operating on direct current from 5 HP to 200 HP.

Design of the P-G Resistance Grid is ideal for safety limit stop operation because it produces a resistor element of sufficient mechanical strength to withstand the brief but heavy overloads peculiar to this service.

Constructed from the same basic parts used for P-G Standard Unit Resistors, long trouble-free service is assured without worry over vibration, moisture or corrosive fumes.

Standard enclosures as illustrated give ample protection from ordinary outside mechanical damage with no sacrifice of ventilation so necessary for dissipation of heat.

Try a P-G Limit Switch Resistor on your next application, particularly, if service conditions are severe.

Detailed information in
BULLETIN No. 500
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P-G

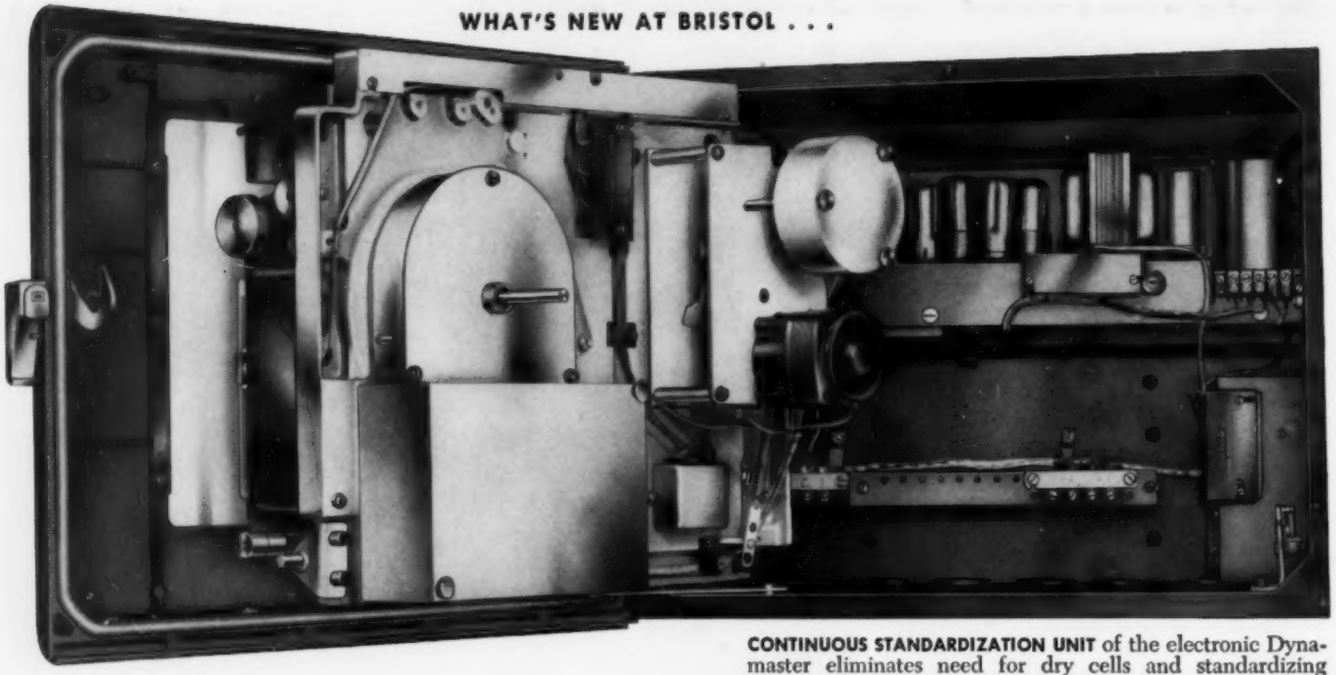
The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

WHAT'S NEW AT BRISTOL . . .



CONTINUOUS STANDARDIZATION UNIT of the electronic Dynamaster eliminates need for dry cells and standardizing mechanism. Result: no interruptions in the operation of the potentiometer for standardization; no batteries to replace.

No time out for standardization here

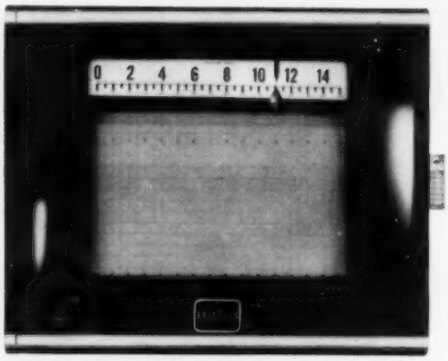
Bristol Dynamaster potentiometer pyrometers give you No-Batt continuous standardization

• You don't have to put up with interrupted performance from old-fashioned potentiometer pyrometers any longer!

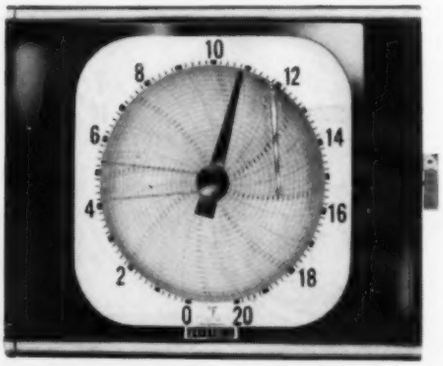
When you use a Bristol thermocouple or radiation-type Dynamaster, you get a *continuous* record or control of temperatures up to 4000°F in any type of fuel-fired or electric furnace or heating equipment. Thanks to the exclusive No-Batt continuous standardization which eliminates the need for dry cells in these electronic instruments, Bristol has been able to do away with interruptions formerly required for periodic standardization.

Bristol electronic Dynamasters are made in round- and strip-chart, single- and multiple-record recorders, air-operated and electric controllers with all types of control actions. Two-pen and program control.

For the complete story on the modern human-engineered Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.



BRISTOL DYNAMASTER CONTROLLERS in either the strip-chart model (shown above) or round-chart model, may be electrically or air operated. 2 position, 3 position, proportional, manual with automatic reset, or proportional input controls. On - off, proportional or reset air controls.

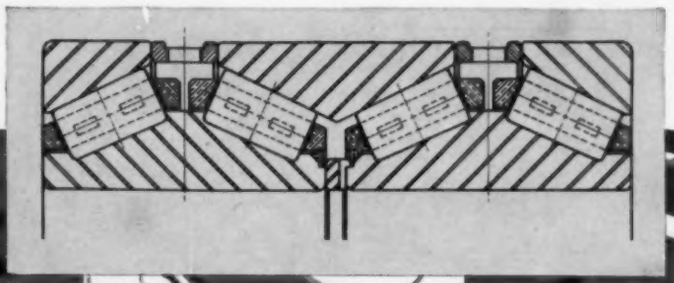


BRISTOL DYNAMASTER RECORDERS come in easy-to-read round-chart (shown here) or strip-chart models. Single record, multiple record or continuous 2 record designs are available. Bristol also supplies all types of time-temperature program controllers.

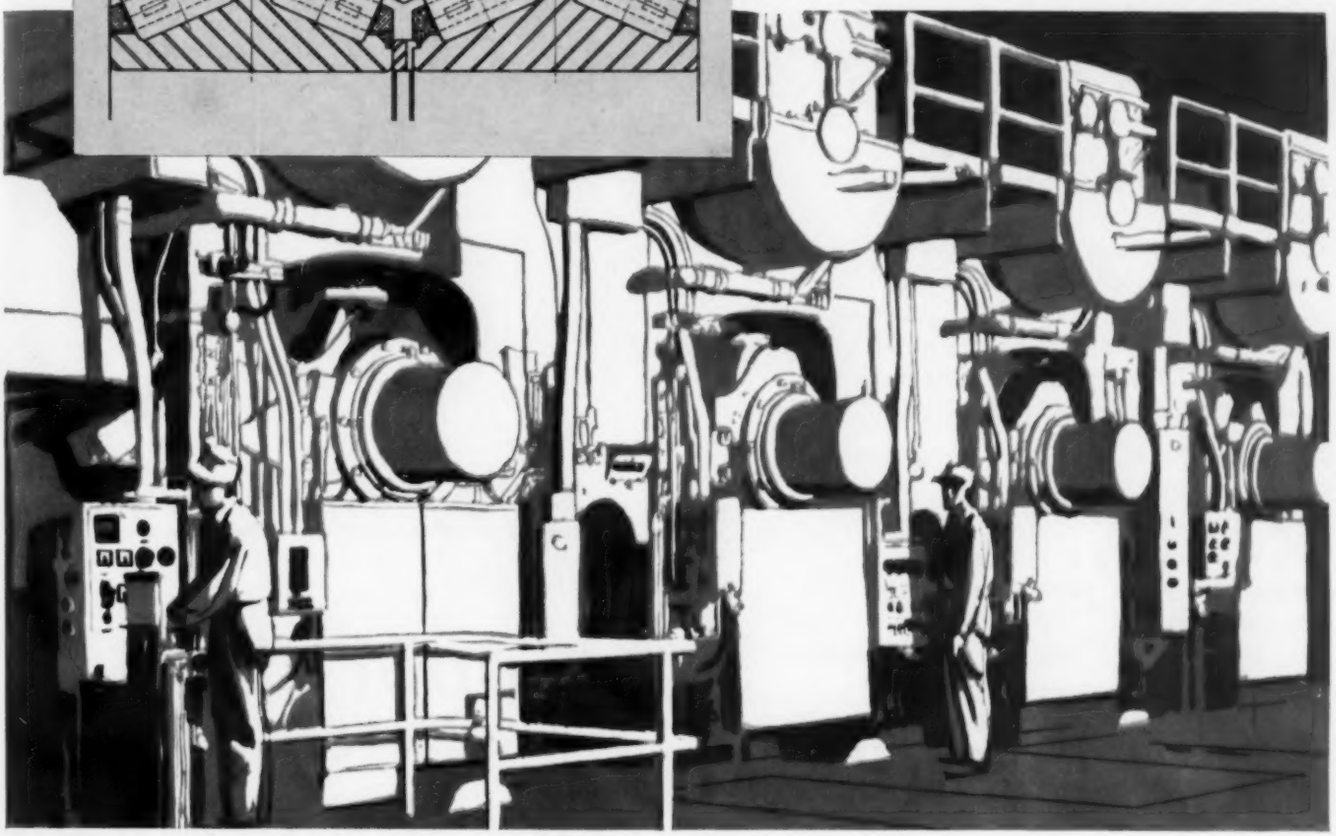
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

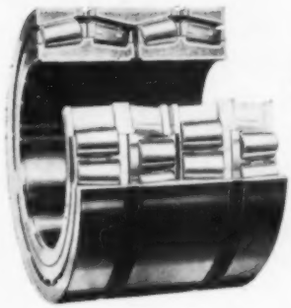
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Precision-ground TORRINGTON Work Roll Bearings—with one-piece cast-bronze cages and machined pads in each roller pocket used in a tandem cold mill by a large steel company.



Built to cut your costs per ton!



Today as never before, lower costs per ton start with the right roll-neck bearings. That's why we say *specify TORRINGTON!*

You'll find in TORRINGTON Bearings the special design features that keep you ahead of today's fast increasing loads and speeds . . . the carefully heat-treated electric-furnace alloy steels that give you maximum toughness, hardness, stability and uniformity . . . the precision tolerances and finishes that give you low eccentricity, uniform load distribution, and minimum friction.

Equally important, you'll find in TORRINGTON's wide range of types and sizes just the bearings you need to handle virtually any combination of thrust and radial loads—smoothly, efficiently, economically.

So specify TORRINGTON for *all* your bearing applications. Your lower costs per ton will prove to you *it pays!*

THE TORRINGTON COMPANY

South Bend 21, Ind. Torrington, Conn.

TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

The instrument that put electronics to work

Before electronics came into the picture, industrial instrumentation was caught in a squeeze. On one hand, it was besieged with demands by production men and engineers for higher sensitivity, faster speeds, and greater reliability. And on the other hand, it was hampered by the limitations of mechanical devices. For the instruments of fourteen years ago were merely mechanical imitations of a man watching a galvanometer needle and twiddling dials. They were too delicate . . . too sensitive to vibration . . . too easily led astray by wear or maladjustment. They just couldn't deliver the performance that new production methods required.

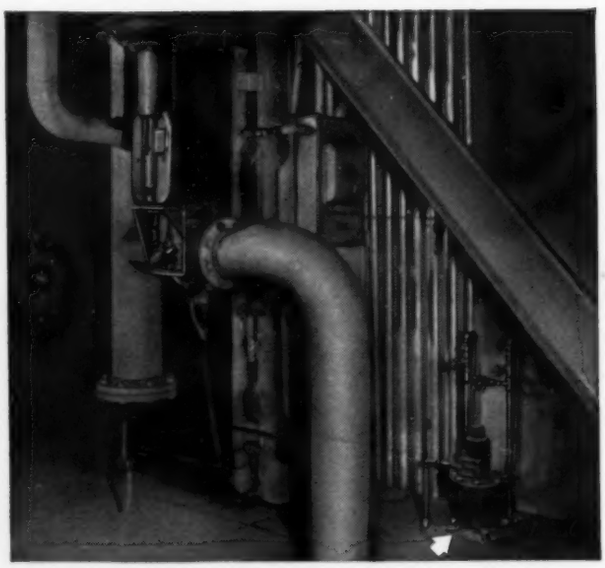
In 1940, however, came a major milestone in the progress of instrumentation—development of the *ElectroniK* potentiometer. This was not only a new kind of instrument. It was a new concept of measurement. For the first time, it applied the science of electronics in a practical way to the design of a measuring device for industry. It replaced complicated, fragile mechanical gadgets with a simple but sensitive electronic circuit and servo system . . . the "Continuous Balance" principle of measurement.

You could tell it was something new when you opened up the *ElectroniK* instrument's case. There was no sign of whirring gears, levers and cams. You could tell it was giving a new kind of performance in measurement, too, by the way the pointer would move swiftly and surely in one smooth sweep whenever the measured variable changed.

The *ElectroniK* instrument gained quick acceptance by production men, engineers, research technicians and maintenance men. They liked the way it provided laboratory accuracy and sensitivity, week after week, under the toughest industrial service conditions. They found that its speed and precision made possible improvements in product quality and process operation that had been unattainable before. And they have proved their confidence by ordering and reordering *ElectroniK* instruments by the thousands . . . not solely because it was *first* of its kind, but because it has continued to be the *best* in performance.

ElectroniK

control of Btu input boosts



Flow meter body (arrow) measures gas flow; ***Honeywell*** *diaphragm operator on butterfly valve throttles input as directed by the* ***ElectroniK*** *instrument.*

Fuel input to these 200-ton open hearths at TC&I's Fairfield Steel Works, near Birmingham, Alabama, is automatically controlled by ***ElectroniK*** *instruments. Small picture shows one of the fuel control systems, consisting of two* ***ElectroniK*** *integrating controllers.*

open hearth efficiency

AUTOMATIC CONTROL of heat input to open hearth furnaces, by means of *ElectroniK* flow instrumentation, is helping to effect important improvements in production and economy at the Tennessee Coal & Iron Division of United States Steel Corporation. By giving the first helper fingertip control over Btu's, TC&I not only makes efficient use of fuel, but also improves steel output by increasing the length of furnace campaigns.

The fuel control system for each 200-ton furnace is designed to accommodate any of four different fuels. One *ElectroniK* instrument is used when firing coke oven gas or natural gas; its double scale is calibrated directly in Btu's per hour for both types of gas. The second instrument is used in conjunction with fuel oil or tar. Each instrument indicates and records flow continuously . . . accurately adds up total flow on a counter-type integrator . . . and automatically positions a control valve in the corresponding fuel line to hold flow at any value designated.

Without leaving the panelboard, the first helper can check the fuel rate at any instant . . . can quickly shift fuel flow to whatever input is required to keep the furnace at proper temperature. At the end of the heat, he has a complete record of furnace input and a precise measurement of Btu's supplied.

ElectroniK instrumentation can probably help your own mill operations in dozens of ways. For a discussion of your specific requirements, call your nearby Honeywell sales engineer . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Catalog 1531, "*ElectroniK* Controllers"... and for Data Sheet No. 6.4-11, "Faster Heat-up for High Temperature Furnaces."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

"...AND LET'S GET SOME

NATIONAL

TRADE-MARK

CARBON BRICK AND SHAPES FOR MAINTENANCE, TOO"

WHEREVER HOT METAL HITS, refractories take a beating. This is true *around* a blast furnace, as well as *in* it. That's why more and more operators are applying the lessons learned in *lining* blast furnaces to maintenance of *other* hot metal areas.

EXPERIENCE HAS PROVED the contributions of "National" carbon and graphite to better production, longer life and lowest maintenance-cost-per-ton in these and other applications:

- RUNOUT TROUGHS
- CINDER NOTCH LINERS
- CINDER NOTCH PLUGS
- MOLD PLUGS
- BEDS AND TRAYS
- SPLASH PLATES
- STOOL INSERTS
- CORES
- SKIMMER PLATES

KEEP THESE STANDARD SIZES ON HAND FOR EMERGENCY!

13½" x 6" x 3" series
9" x 6" x 3" series
9" x 4½" x 2½" series

★

Write for Catalog Section S-6210

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

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A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, New York
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: Union Carbide Canada Limited, Toronto

Personnel News...

James A. Farrington, founder and first president of the Association of Iron and Steel Engineers and special assistant to the plant engineer at Wheeling Steel Corp., Steubenville, Ohio, retired April 1, completing a career which began in 1903. Nationally recognized as a pioneer in the application of electrical drives and controls for plant operations and for the introduction of safety applications, Mr. Farrington began his Wheeling tenure on August 1, 1903, as superintendent of LaBelle Iron Works, Steubenville, remaining in charge throughout a period of important expansion. He assumed his final post in July, 1951. Born in Terre Haute, Ind., December 28, 1873, Mr. Farrington attended schools there and graduated from Rose Polytechnic Institute in 1896. He received a Master of Science degree in electrical engineering in 1900. The AISE recently established an annual scholarship in his name at Rose Polytechnic Institute.

Thomas H. Knox was appointed superintendent of the sheetmill division at the Allenport, Pa. plant of Pittsburgh Steel Co. In his new position, Mr. Knox will supervise operations at the company's new hot and cold rolling mills. He succeeds **W. Harrison Webb,** who resigned to accept a position with another company. Also announced was the appointment of **Paul Totten** as superintendent of cold reduction. Under Mr. Knox, he will supervise operations of pickling, cold reduction, annealing and temper rolling. Mr. Knox began his career with Wheeling Steel Corp. when he was 19. Four years later, he became a roller on Wheeling's 8-stand continuous sheet and tin bar mill. In 1937, he joined Jones & Laughlin Steel Corp. as a roller to assist in bringing in the 96-in. continuous hot sheet mill at Pittsburgh. He served as a roller on that mill until he recently joined Pittsburgh Steel to become superintendent of hot rolling. Mr. Totten started with the Thomas Steel Co. as plant metallurgist in 1948. In 1950, when Thomas became the Thomas Strip Division of Pittsburgh Steel Co., he became general foreman of the annealing department. In 1952, he advanced to general foreman of rolling and finishing at Thomas. Recently, he transferred to Allenport as a consultant on proving-in the new cold rolling mill, annealing furnaces and temper mill.

Paul A. Karns, recently associated with John A. Roebling's Sons Corp., was named manufacturing manager, cold rolled products division of Crucible Steel Co. of America's Spaulding works, succeeding **William D. Cross,** who will retire May 31. Mr. Karns began his career in 1919 at the Franklin plant of the Cambria Steel Co. in Johnstown, Pa. In 1923 he joined the Stanley works, at Bridgeport, Conn., as chief clerk and was made superintendent of the company's cold rolling mill in 1935. He became associated with the John A. Roebling's Sons Corp. as superintendent of the flat shop in 1940 and was manufacturing manager of that company's cold rolled products division when he resigned to join Crucible.

Edward A. Parker has been appointed superintendent of the plate and 86-in. hot strip mills of Kaiser Steel Corp. He was previously assistant superintendent in the same department since early 1953. He succeeds **Joseph E. Macorey** who will assume new duties at the plant.

James K. Watkins was appointed chief engineer of the Crucible Steel Co., Midland, Pa., works. He will have complete charge of all engineering services. Mr. Watkins succeeds **John Ferm** who has retired. Mr. Watkins joins Crucible after serving since 1944 as chief engineer for Pittsburgh Steel's Monessen works. Prior to this assignment he served as chief draftsman and plant engineer. Mr. Ferm closes a 30-year career with Crucible. He was primarily responsible for the engineering involved in the $70,000,000 expansion and improvement program at the Midland works since World War II.

William S. Tuttle has been appointed superintendent of the Troy, N. Y., coke plant of Republic Steel Corp. Mr. Tuttle succeeds **J. H. Kunkle, Jr.,** who has been named superintendent of Republic's Warren, Ohio, coke plant.

Louis E. Wolfson, chairman of the board and president of Merritt-Chapman & Scott Corp., was elected to similar posts with Newport Steel Corp. in a realign-

JAMES A. FARRINGTON

THOMAS H. KNOX

PAUL A. KARNS

EDWARD A. PARKER

ment of Newport directors and officers following acquisition of a majority interest in the company by Merritt-Chapman & Scott. Elected to the Newport board along with Mr. Wolfson were: **Lewis M. Schott, Elkin B. Gerbert** and **Alexander Rittmaster.** As board chairman and president of Newport Steel, Mr. Wolfson succeeds **Frank S. Gibson, Jr.**

Robert A. Stauffer and **Kenneth G. Donald** were elected to the board of directors of National Research Corp. Mr. Stauffer has been vice president and director of research since 1949. He is also vice president and a director of Vacuum Metals Corp., jointly owned by Crucible Steel Co. of America and National Research Corp.

Joseph M. Schaeffer was named president of Waterbury Farrel Foundry & Machine Co. Mr. Schaeffer was formerly a vice president and director of the company and chief engineer of the bolt, nut and screw machinery

JOSEPH M. SCHAEFFER

division. **Richard L. Wilcox,** former president, was elected chairman of the board to succeed **David C. Griggs,** the retiring chairman. Mr. Griggs will continue as a director of the company. Vice presidents re-elected were **Fred S. Van Valkenburg** and **Irving H. Tolles. Richard C. Bannon,** Cleveland office sales manager, was newly elected as vice president. **A. Dale Mitchell** was elected to the office of treasurer, succeeding **Lewis S. Reed** who is retiring.

W. W. Hofmann, assistant chief engineer, Johnstown plant, Bethlehem Steel Co., was transferred on April 1 to Bethlehem Pacific Coast Steel Corp. as chief engineer of construction. Other promotions announced are that of **Robert S. Bogar,** now assistant electrical superintendent, who has been promoted to the position of assistant chief engineer at the Johnstown plant. **John F. Worden** replaces Mr. Bogar as assistant superintendent of the electrical department, and **Herman W. Ober** has been promoted to assistant to superintendent electrical department, replacing Mr. Worden.

Cecil B. Dodd and **Robert H. Miller, Jr.** were appointed assistant managers of the industrial relations department of Weirton Steel Co. They will be responsible for all administrative functions of the department under **E. A. Ross,** manager.

Paul J. Pismato was appointed assistant superintendent of the plate and 86-in. hot strip mills at Kaiser Steel Corp. Mr. Pismato has been with Kaiser since 1943,

PAUL J. PISMATO

progressing through various supervisory positions from mill provider to shift foreman, then general foreman until his recent appointment. He was formerly with Jones and Laughlin, Republic Steel at Gadsen, Ala., and Dominion Steel, Nova Scotia.

Robert W. Knauft was appointed president of the Charles Taylor Sons Co. In addition, the following ap-

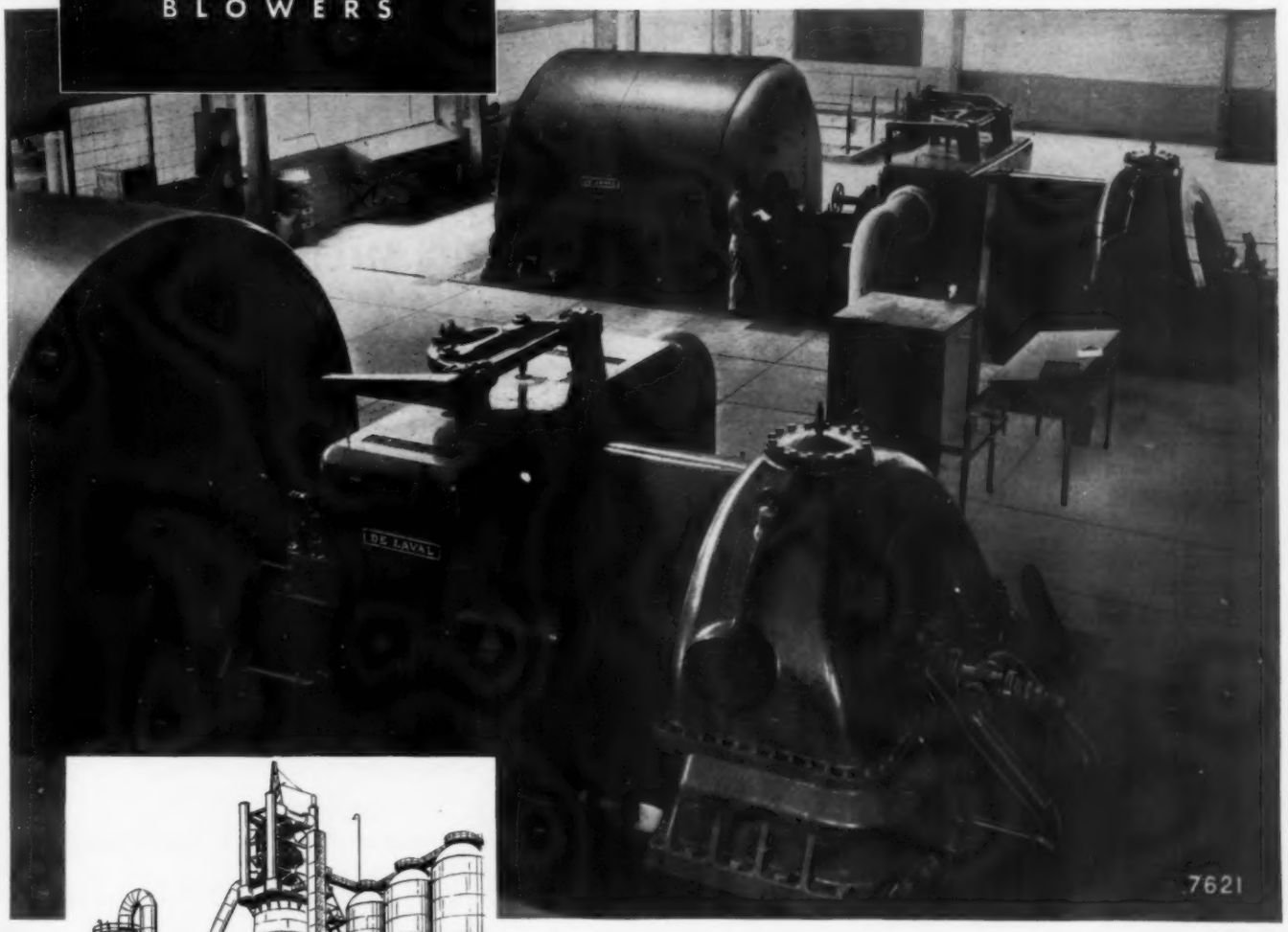
ROBERT W. KNAUFT

pointments were announced: **M. C. Booze,** vice president, **L. J. Woodcock,** treasurer and **J. B. Henrich,** secretary.

E. H. Millard, works manager and director of Fort Pitt Bridge Works has retired, and **H. Frank Coulter** has been named plant manager. Mr. Millard had been a director of Fort Pitt Bridge since 1944 and works manager since 1941. He had a long career in the steel fabricating industry. Mr. Coulter, formerly assistant works manager, joined the company in 1940 as an administrative assistant. Previously he had been associated with Bethlehem Steel Co. and Ingalls Iron

DE LAVAL STEEL MILL BLOWERS

designed for giant furnaces



These twin De Laval blowers, on the job in a leading mid-western steel mill, are among the largest ever built. Each is a five-stage unit with a rated capacity to deliver 121,000 cfm of air at 35 psig discharge pressure. Each is driven by a 15,220 hp, 2,500 rpm De Laval 16-stage steam turbine operating under steam conditions of 400 psig, 750 F with 28 in. vac.

The total weight of each De Laval turbine and blower is over 167 tons; the blower alone is over 212,000 lbs. Shafts of the turbine and blower were made large and heavy to meet the wide range of varying speed conditions required in blast furnace service. Outside diameter of the blower casing is 12 ft. and it is divided horizontally in the plane of the shaft. This permits raising the upper half of the casing for easy access to all interior parts. • For a quarter of a century, De Laval has pioneered in advanced blower engineering designs and practices. De Laval builds single and multi-stage centrifugal blowers and compressors for service in steel, gas and coke plants. Discuss your specific applications with a De Laval Sales Engineer.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL-234

Greater Production of Better Products

WITH

MORGAN WORCESTER

ROLLING MILL EQUIPMENT

The First Morgan Continuous Rolling Mill

Modern Morgan Rolling Mills have been specifically developed by skilled technical pioneers to meet the demands of mass production. Their contributions, as partially listed at the left, have given industry the rolling mill equipment it needs to produce . . . more products . . . better products . . . at less cost.

Made with skill, Morgan equipment produces larger tonnages more easily, with greater safety. Bring your problem to Morgan.

A few Morgan Rolling Mill Contributions Developed and Patented since 1882

- Continuous Billet and Sheet Bar Mill
- Continuous Skelp Mill
- Continuous Mill—Twist Guides
- Automatic Rod Reel
- Continuous Billet Heating Furnace
- Hydraulic Flying Shear
- Steam Flying Shears
- Up and Down Cut Flying Shear
- Duo-Finishing Mill
- Escapement Type Cooling Bed
- Universal Type Cooling Bed
- Carry-over Type Cooling Bed
- Automatic Pack Annealing on Cooling Bed
- Four Strand Rod Mill
- Double Strand Merchant Mill
- Skew Y Reversing Tables
- Edging Mills
- Vertical Mills
- Morgoil Bearings
- Automatic Billet and Slab Separating Skids
- Electric Crop and Cobble Shear

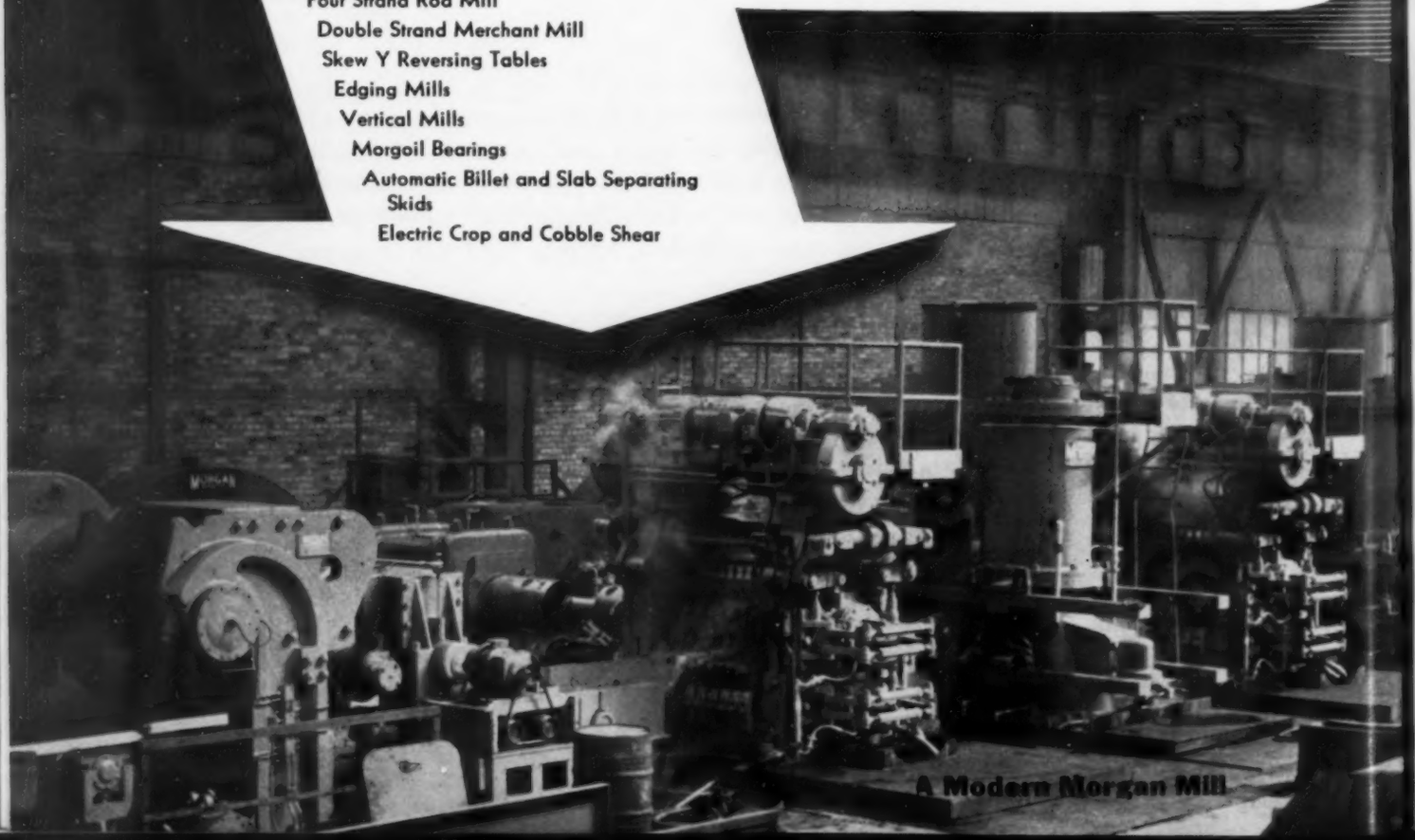
MORGAN CONSTRUCTION COMPANY

WORCESTER, MASSACHUSETTS RM-55

Rolling Mills—Wire Mills

Gas Producer Machines—Regenerative Furnace Control

English Representative:
International Construction Co., 56 Kingsway, London, W. C. 2, England



A Modern Morgan Mill

Works. He became assistant to the works manager in 1947.

Jack F. Major has been appointed assistant superintendent of the Campbell Coke plant of the Youngstown Sheet & Tube Division, U. S. Steel Corp. Also appointed at Campbell were **Carl A. Boehme** as superintendent of the cold strip mill; **Cecil C. Williams** and **John H. Stone** assistant superintendents of the cold strip mill; **E. O. Reese,** superintendent of the hot strip mill; **S. Howard Betts,** assistant superintendent hot strip mill; **John M. McGunigal,** assistant superintendent of the fuel division, fuel and power department; and **William C. Campbell,** assistant superintendent of the merchant mills at Struthers.

James J. Munns has been elected vice president of National Steel Corp. in charge of research and quality control. Mr. Munns has been identified with National Steel since 1935, serving in research and related capacities with various subsidiaries of the company. In his new position, he will have over-all direction of research and control of quality throughout the corporation.

L. D. Richardson has been named national sales and service supervisor by the Eutectic Welding Alloys Corp. His new duties will include supervision of sales, sales training and service in the U. S. and Canada.

Joseph H. Gray was appointed sales representative for the Pittsburgh office of Harbison-Walker Refrac-

JOSEPH H. GRAY

tories Co. He formerly was Pittsburgh district sales manager for Clipper Saw & Manufacturing Co.

Guy W. Shurmer has retired as division superintendent of the American Steel & Wire Division wire mill at Cuyahoga Works. He started as a weigher at the old Newburgh Wire Works in August of 1908. He progressed through a number of positions in that plant, becoming foreman in 1926, and general foreman ten years later. In 1943 he was made works superintendent of the Newburgh plant and two years later was promoted to superintendent in charge of the wire mills in the giant Cuyahoga Works.

Ralph Winslow was named departmental vice president of Koppers Company, Inc. Mr. Winslow has been manager of Koppers public relations department since January, 1947, with responsibility for the company's general, industrial and consumer advertising, sales promotion, press and public relations, and employee communications.

John J. Webber has been appointed sales engineer in the Pittsburgh technical sales department of Harbison-Walker Refractories Co. He had been with Owens-

JOHN J. WEBBER

Corning Fiberglas Corp. where he served as chief furnace engineer in charge of furnace construction and refractories.

Christian F. Beukema has been appointed vice president of Michigan Limestone, division of United States Steel Corp. Mr. Beukema has been general manager of operations of the division for the past year.

Fred E. Harrell, vice president of Reliance Electric & Engineering Co., has been given the additional duties of director of special projects, a newly created position in which he will be concerned with new building projects and associated growth problems of the company. **Hugh D. Luke,** formerly manager of central production planning, becomes manager of manufacturing of rotating equipment, and **Stephen W. Feiss,** formerly a manufacturing staff project engineer, is appointed general superintendent of the company's Ivanhoe division.

William P. Bleil has been appointed district representative of the Aerovent Fan Co., Inc., of Piqua, Ohio, for Mo. and Kan. He has opened a sales and engineering office at 4 North Eighth St., St. Louis, Mo.

James M. Helme has been appointed director of industrial relations of Joseph T. Ryerson & Son, Inc. Mr. Helme was associated with the Inland Steel Co. for 19 years before joining Ryerson in 1953 as manager of the industrial relations department. His headquarters are at the firm's Chicago plant.

Dr. Joseph Remenyi was named chief design engineer of Waldrip Engineering Co. He is a specialist in

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upon request

New 1954 Booklet on

Aire-Rectifier Exclusive Features

• This new booklet illustrates the many exclusive features that make the Lintern Aire-Rectifier the choice of practically every steel and industrial plant using air conditioning on crane cabs and pulpits — features which assure unequalled cooling and filtering of the air at the lowest possible cost — features which have proven their worth in hundreds of applications while keeping maintenance costs at a minimum.

With this new booklet and Bulletin AC-533 you can select the right model Aire-Rectifier for the particular temperature range of the crane in mind.

Accompanying the description is a chart of applications (type of crane operation) temperatures encountered, and model recommended for the particular conditions.

By selecting the air conditioner of the proper size for the job, substantial savings are possible as compared with buying a unit designed for high temperature ranges when one for lower temperatures would answer the purpose satisfactorily.

Ask for Bulletins AC-544 and AC-533—yours free upon request.

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highly stressed parts for heavy equipment, having devoted a great deal of his attention in Europe to the ore crushing industries. He holds many patents in Europe on various types of crushers, including a roll crusher which has both horizontal and vertical motion. Dr. Remenyi was associated with the Skoda works in Czechoslovakia, and later for many years was with Raupach Co., Ltd., in Germany.

S. K. Hostetter, Jr., sales manager of Elliott Co.'s Crocker-Wheeler division for the past year, has been named general manager of the division. Mr. Hostetter

S. K. HOSTETTER

joined Elliott in 1934. Before going to the Crocker-Wheeler division he had been in the company's Washington, D. C., office, first as a field engineer and then as district manager for ten years.

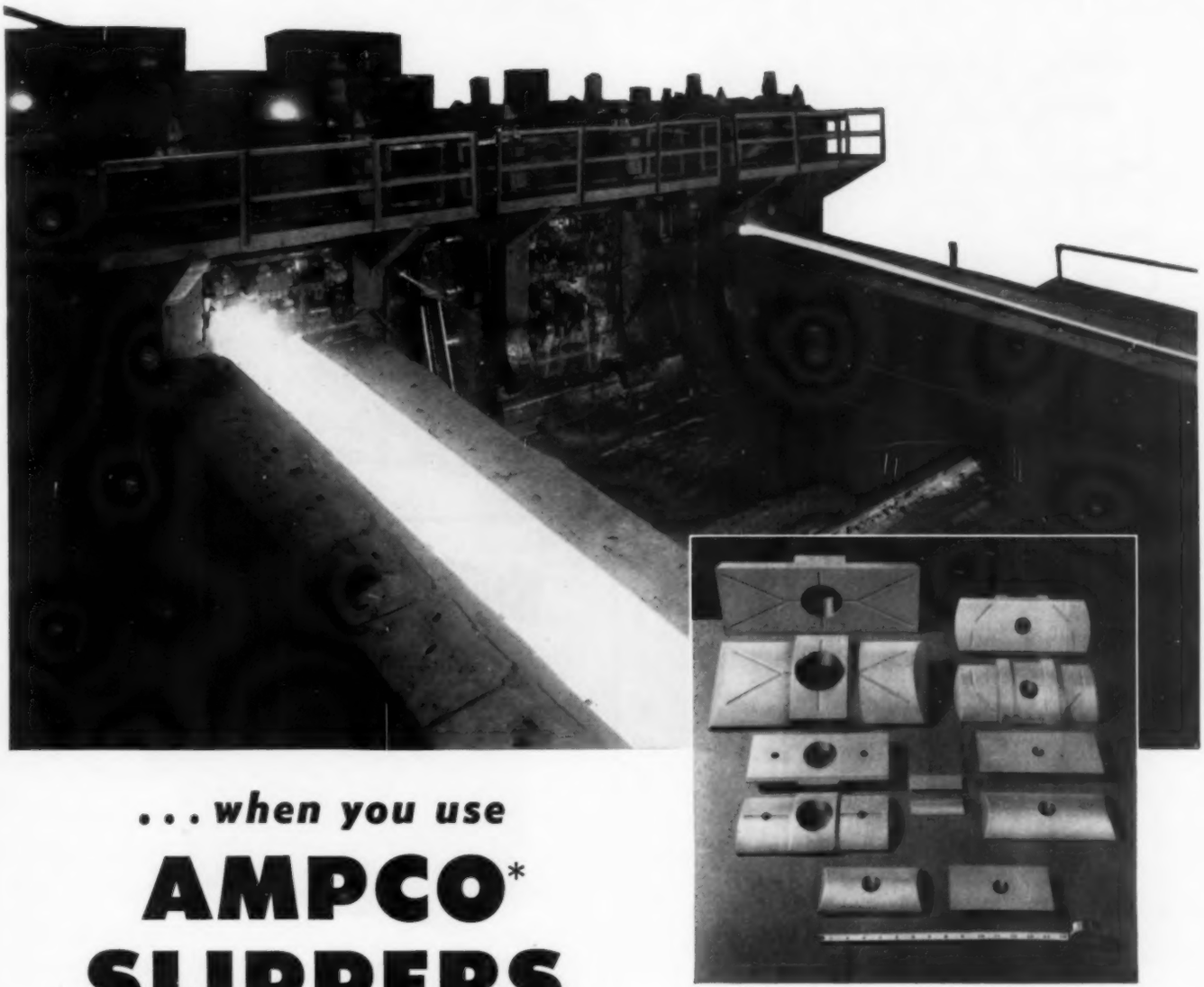
M. W. Zolton was named general manager in charge of the manufacturing and engineering facilities of the York-Gillespie Manufacturing Co. Mr. Zolton has 18 years' experience in production and management in heavy industry. He leaves a post with Barium Steel Co. as manager of that firm's special products division at Pelham, N. Y. Formerly with Mesta Machine Co. as a foreman, he was vice president in charge of operations for Steel City Engineering & Construction Co. before leaving to manage the Barium Steel plant.

Arthur M. Grasse was elected vice president in charge of industrial products of Goodman Manufacturing Co. Mr. Grasse, associated with Goodman for 33 years in various divisions of the business, has been manager of its industrial manufacturing division. He will continue in charge of this division as well as the newly acquired Diamond Iron Works line of crushing, screening and handling equipment.

James Ramsey, Jr. has been appointed general traffic manager of American Steel & Wire Division of United States Steel Corp. Mr. Ramsey succeeds **Robert H. Haley,** whose retirement after 51 years with the division was announced recently. In taking up his new post, Mr. Ramsey will be responsible for the transportation and dispatching of the Wire Division's millions

(Please turn to Page 201)

Production Steps Up Costs Step Down



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These properties mean lower costs for you — less downtime — longer runs without replacement.

You get these slippers in the form you need to meet your specific operation. They're available "cast-to-size" or as rough castings. "Cast-to-size Slippers" come either with tolerances of minus 0, plus 1/32; or plus 0, minus 1/32. Oil grooves are cast in, if you want them.

And that's not all. Ampco Metal's stamina, toughness, and corrosion resistance mean that it's ideally suited for cutting costs in other steel-mill applications, too — screw-down nuts, wear plates, flash-welder dies, pickling equipment. Get the whole money-saving story from your nearby Ampco field engineer or write us direct

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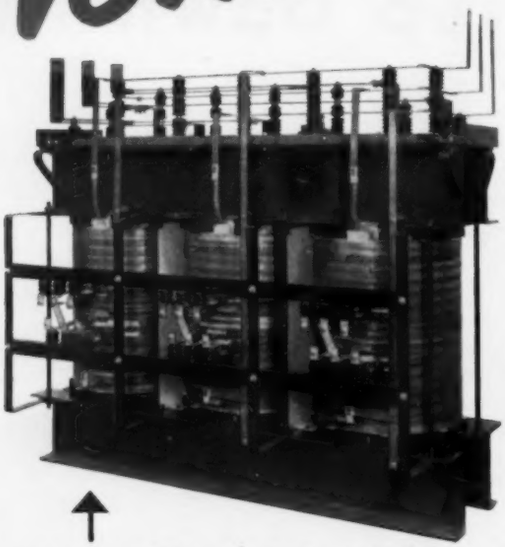
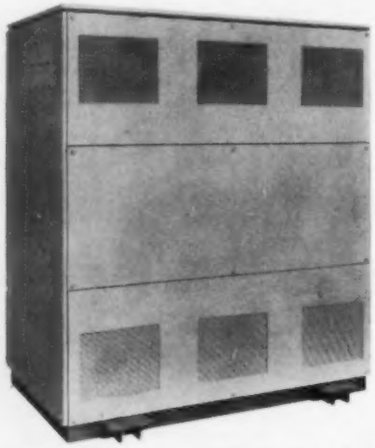
Now...84 Pennsylvania

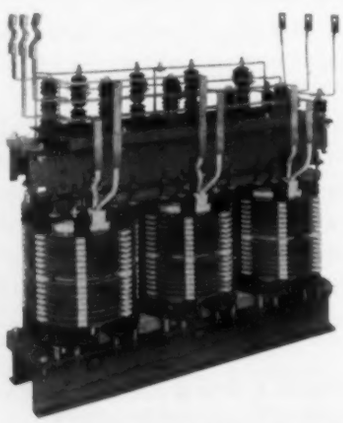


2000 Kva, 3 Phase, 60 Cycles, 150°C. Rise.
2400Δ-480Δ volts.
Station auxiliary, sealed-in-nitrogen.

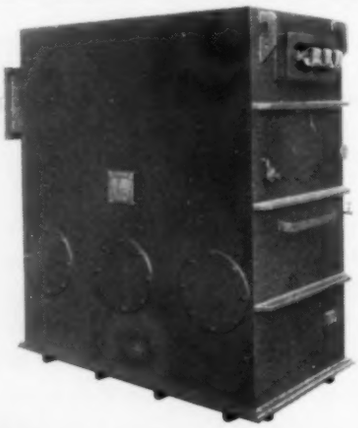


1000 Kva, 3 Phase, 60 Cycles, 150°C. Rise.
12,470Y-480Δ volts.
Unit substation service, ventilated type.

1000 Kva, 3 Phase, 60 Cycles, 150°C. Rise.
12,000Δ-480Y/277 volts.
Unit substation service, sealed-in-nitrogen.



500 Kva, 3 Phase, 60 Cycles, 150°C. Rise.
2400Δ/4160Y-480Δ volts.
Network, submersible, sealed-in-nitrogen.



500 Kva, 3 Phase, 60 Cycles, 150°C. Rise.
12,500Δ-216Y/125 volts.
Network, submersible, sealed-in-nitrogen.

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No doubt about it — Class H transformers are the greatest transformer development of the last decade. Nothing like it has captured the imagination of the transformer industry since the introduction of cold rolled steel.

Pennsylvania Transformer engineers have pioneered the development of Class H insulating materials and are credited with designing and placing into service the world's largest Class H units.

Eighty-four Pennsylvania Class H transformers, ranging in size from 250 Kva through 2000 Kva — up to and including 15 Kv — are installed in unit substations, network systems, and generating stations throughout the country. The trouble-free operating record of every one of these units is substantial proof of the outstanding electrical and mechanical designs of Pennsylvania Class H Transformers.

Among the many advantages of Class H Transformers are the following:

- Safest transformers ever developed;
- No fire or explosion hazard;
- Carry the lowest fire insurance rates;
- Least affected by water;
- Exceptionally high overload capacities;
- Minimum maintenance — even in highly contaminated areas.

PENNSYLVANIA CLASS H TRANSFORMERS are available in the following sizes:

	KVA	VOLTAGE
Ventilated	Up to 3000	Up to 15 Kv
Sealed-in-Nitrogen	Up to 2000	Up to 15 Kv

For further information on Pennsylvania Class H transformers, we invite you to write to Pennsylvania Transformer Company, Box 330, Canonsburg, Pa., and ask for your free copy of Bulletin 951 — "H . . . in a Class by Itself."

PENNSYLVANIA TRANSFORMER COMPANY

A McGRAW ELECTRIC COMPANY DIVISION

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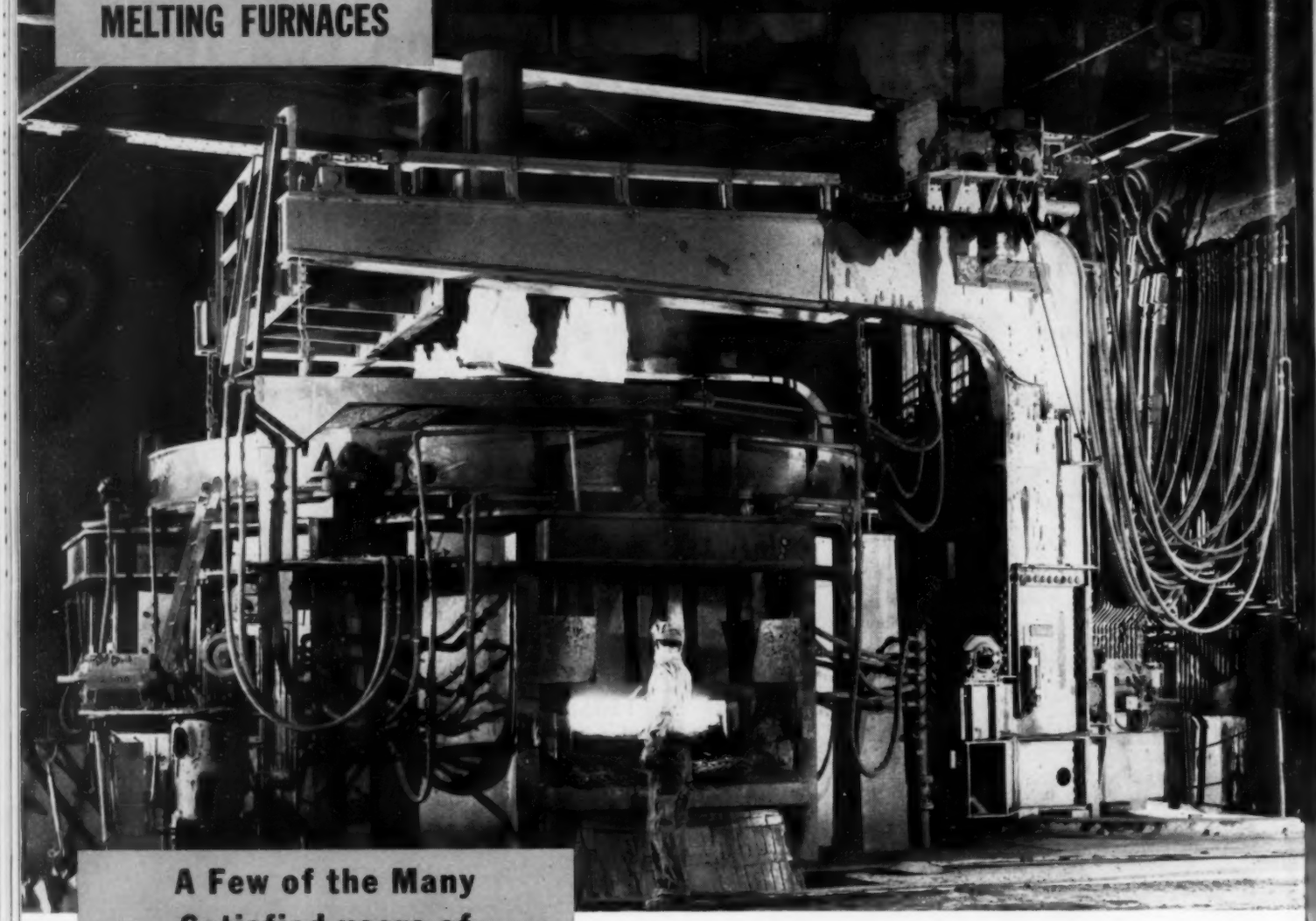

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American Steel Foundries
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Ingersoll Steel Division, Borg-Warner Corp.
McLouth Steel Corporation
Ohio Steel Foundry Company
Republic Steel Corporation
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UNITED STATES STEEL

of tons of incoming raw materials and outgoing finished products in 14 plants, located in nine cities in the northeastern quarter of the United States. He was priorities analyst for United States Steel Corp. for a year before joining the Wire Division as a senior priorities analyst in December, 1943. The following September, he was promoted to the position of priorities administrator in charge of the interpretation and administration of all rulings and regulations of the War Production Board. Following the war he was made sales statistics supervisor and held that position until he was transferred to the post of staff assistant in the president's office on March 1, 1950. Almost two years later he was appointed assistant to general traffic manager of the Wire Division, and on April 1, 1953, he was named assistant general traffic manager—a post he has held until the present time.

Arthur W. Gulliver was appointed to the New York office staff of Dravo Corp. as application engineer to handle the sale of fabricated piping. Prior to joining Dravo, he was sales engineer for Walsh-Holyoke Fabricators, Inc., eastern sales manager for Kerotest Manufacturing Co., a subsidiary of Tube Turns, Inc., and sales engineer for Tube Turns, Inc.

Howard M. Fitch, general manager of the Herman Nelson division, has been elected a vice president of American Air Filter Co., Inc. Joining AAF as a sales engineer in June, 1936, Mr. Fitch served as production manager, manager of the legal and patent department, and assistant to the executive vice president, before becoming manager of the Herman Nelson Division in 1953. He developed the Cycoil oil-bath air cleaner used on large stationary diesel engines.

F. Jerome Tone, Jr. was made senior vice president and **Frederick T. Keeler** was appointed director of sales for the Carborundum Co. Mr. Tone, a member of the board of directors and vice president of sales, since 1942, will have broad executive responsibilities assisting and representing the president in many phases of the business. He will also work with all elements of the company and its subsidiaries in the fields of distribution, sales and related activities. Mr. Tone will continue as chairman of the company's abrasive sales operating committee. Mr. Keeler, formerly director of the marketing branch of the sales division, will be responsible for the functional direction of the sales programs of the company and its subsidiaries. Mr. Keeler, consulting with operating divisions and subsidiaries, will formulate and recommend the policies, programs, plans and procedures concerning the company's sales programs. In addition, Mr. Keeler will serve as vice chairman of the abrasive sales operating committee.

William G. Gray was named manager of railway sales for the Pyle-National Co. He formerly was associated with various railroads throughout the country, and with the Pittsburgh Steel Co., and Union Asbestos & Rubber Co.

Robert Drake has joined Carboloy department of General Electric Co. as a field sales representative for the organization's Atlantic District. He will be attached to the Philadelphia, Pa., sales headquarters. He was formerly with Thompson Aircraft Co. and Eaton Mfg. Co., both in Cleveland.

D. W. McGeorge was named vice president of sales of Edgewater Steel Co. He formerly was vice president and general sales manager. **Walter M. Cree** was promoted to general sales manager from assistant general sales manager. **W. O. Fleming** was appointed manager of industrial sales; and **R. G. Snively** was named assistant manager of industrial sales.

Obituaries

Alexander Morton MacCutcheon, retired senior vice president and director of Reliance Electric & Engineering Co., died March 4. He joined Reliance in 1914, in charge of all new design work, and was made chief engineer of the company in 1917. In 1920 he was elected a director and became vice president in charge of engineering in 1923. He retired in 1946.

Walter C. Pijawka, superintendent of electric melting at the Midvale Co., Philadelphia, Pa., died March 5. Mr. Pijawka had entered the service of the company in 1923 and had been in charge of electric melting since 1946.

Martin J. Anderson, 65, an engineering executive for Mathews Conveyer Co., Ellwood City, Pa., for approximately 30 years, died March 9. Mr. Anderson was chief engineer for the company for many years and recently had been serving as director of engineering and research.

Everett E. Smith who represented Morganite, Inc., in Chicago, Ill., died February 27. He came to Morganite in 1920 from Westinghouse Electric Corp.

Herbert L. Bergman, chief erection engineer of Surface Combustion Corp. for 25 years, died March 4.

Fred S. High, superintendent of rolls at the Midland works of Crucible Steel Co. of America, died April 4.

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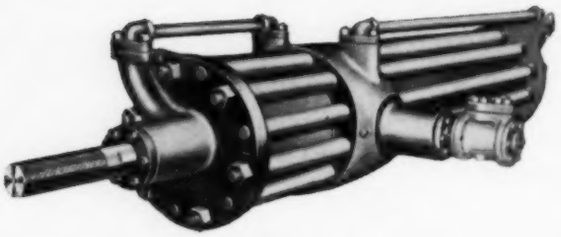

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And this style of cylinder is only one of many, all of which embody "extra" features of design and construction; features that, as a result of our long experience in building heavy duty hydraulic equipment, mean trouble free performance.

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(1) Heat Treating Furnaces

Available from the R-S Furnace Corp. is a new catalog covering its furnace line. It includes descriptions and applications of the following types of heat treating furnaces: car hearth, rotary hearth, pit, roller hearth, belt, chain, pusher and "Hi-Head." The "Hi-Head" furnace is a unit of small cross section for rapid, continuous handling of long, straight stock, such as bars, pipes, tubing and slabs, regardless of length. (Bulletin 200).

(2) Electrical Modernization in Industrial Plants

A 16-page booklet on electrical modernization in industrial plants is available from Westinghouse Electric Corp. It points out that while modernization is the key to successful competition, the first step in any modernization program must be the efficient distribution of electrical power. Special sections of the booklet show how a modern electrical system can (1) increase output, (2) lower operating cost, (3) reduce down-time and maintenance, and (4) increase safety and reduce safety protective rates. The principal elements of a modern electrical system are described and illustrated, and their advantages outlined. (Booklet B-6133).

(3) Backstand Idler

A new, low cost idler for all types of wall, bench and floor, coated abrasive backstand grinding and polishing operations, is announced by the Carborundum Co. Designed for heavy-duty production grinding, as well as for intermittent light polishing jobs which call for frequent setup changes, the new backstand idler permits belts of the same length to be employed with contact wheels of various diameters. Varying widths of belts can be used, ranging from ½ in. to 8 in., due to a patented belt tracking mechanism and highly sensitive tension adjustments. The tracking device eliminates the need for precise center alignment between idler pulley and contact wheel, thus minimizing downtime during contact wheel change-overs. A linkage-type arrangement permits finger-tip manual adjustment of tension and tracking.

(4) Magnetic Transmission Equipment

The release of a new magnetic brake and clutch bulletin is announced by Stearns Magnetic, Inc. It provides a ready reference for figuring the right transmission equipment for individual applications and contains complete figures, diagrams, dimensions, capacities, horsepower and torque ratings on clutches, brakes and clutch-brake combinations. (Bulletin 226-C).

(5) Electrical Design for Hazardous Locations

The latest of an annually revised series of 16-page bulletins distributed by Crouse-Hinds Co. explains why electrical equipment for hazardous locations is designed and built as it is. This well-illustrated booklet covers explosion pressure dynamics and why explosion-proof lighting fixtures, control boards and receptacles — are necessary for safe operations at Class I (explosive gases or vapors) or Class II (combustible dusts) locations. (Bulletin 2660).

(6) Weld Wall Chart

A colorful and informative wall chart is available from Ampco Metal, Inc. It incorporates a total of nine valuable data charts and ten photographs. The feature chart in the upper left corner includes the R.W.M.A. specifications for spot welding similar and dissimilar metals. The other eight data charts, of the three-color presentation, cover the average properties of high conductivity alloys, projection welding, conversions on the commonly welded metals, heat balance, secondary amperes and electrode force, seam welding and spot welding schedules on low carbon steel. The photographs show holders, tips, seam welder shafts and bushings, seam welder wheels, back-ups, dies and tips.

(7) Portable Temperature Indicators

Recently issued by the Foxboro Co. is a bulletin describing two portable temperature indicators, the potentiometer indicator and the resistance thermometer. Described in detail are operating adjustments, features of design, test circuits, measuring elements and instrument specifications. An entire page is devoted to listing the standard scales available, covering temperatures from —200 F to +2800 F. Tables also list the type of thermocouple or resistance bulb recommended for each range, as well as the degrees of temperature indicated by each scale division. Also covered is the use of portable pyrometers in checking installed pyrometric instruments and in replacing potentiometers which are temporarily out of service. (Bulletin A-303).

(8) Clutchless Drive

Design, operation and maintenance of the recently introduced, clutchless "Hydratork Drive" is covered in a new eight-page illustrated brochure published by the manufacturer, Clark Equipment Co. Material covered by the brochure includes a description of the operational details of the torque converter and special-design constant-mesh transmission. Illustrations include close-up photographs of cutaway working production units. Photographs also show assembly and disassembly of the drive. Operational advantages offered by this type of drive are discussed and illustrated with drawings.

(9) Core Dryer

How to make better cores in less

time at lower cost with a "Foundromatic" sand core dryer is described in a new 12-page bulletin released by Allis-Chalmers Manufacturing Co. The bulletin describes the important features of the core dryer that result in simplified core making and explains how such drying fits existing setups. It carries a performance chart which shows that the moisture content in a core determines the amount of electrical energy absorbed by the core while it is between the electrodes. Answers are also supplied to 19 commonly asked questions concerning the operation. (Bulletin 15B7306C).

(10) Multiple Plunger Pillar Presses

A new folder published by Waterbury Farrel Foundry and Machine Co., gives extensive details on the company's modernized line of multiple plunger pillar presses. Complete specifications and capacities are given in tabular form for six sizes of presses. The bulletin illustrates several sizes of the machines and pictures examples of the type of work produced on them. Close-up views show details of important portions such as the tooling arrangement. Included are descriptions of the modern design features which give these presses greater efficiency, easier operator control, economy of operation and increased flexibility. Among the features covered are automatic work control, accessible tooling and independent tool adjustments, roll feeds, finger motion with safety device, air clutch, etc. Information is also given on accessory equipment such as straightener and feeder, scrap winder and scrap cutter.

(11) Bronze and Copper Castings

Publication of a 24-page illustrated booklet which presents the cast bronze and copper products of the National Bearing Division of the American Brake Shoe Co. is announced. Sections of the booklet deal with the firm's research, process, engineering and production facilities. The publication also offers an alloy chart listing the composition, analyses, properties and applicable specifications of copper, babbit, bronze and aluminum alloys. Performance characteristics and specific product uses of the alloys are listed in a casting guide section.

(12) Control Motors

A catalog made available by Minneapolis-Honeywell Regulator Co., covers their complete line of industrial control motors and industrial motorized valves. Included are specifications, ordering information, and a price supplement for these motors. Data-log also contains information and specifications for the use of industrial control motors with globe, adjustable port, butterfly valves, or combinations.

(13) Compacting Press

Recently released by Baldwin-Lima-Hamilton Corp. is a bulletin which describes the model "L," 50-ton powdered metal compacting press, and lists its design specifications. A table of exclusive features explains how the press is designed for high-quality, low-cost production in the fabrication of parts from metal powders. (Bulletin 3104).

(14) Explosion Proof Housings

Complete information on all sizes of its new line of explosion proof housings for enclosing such electrical equipment as fuses, relays, motor starters and other equipment that must be operated in explosive atmospheres is described in a bulletin published by Adalet Manufacturing Co. These housings are made of cast aluminum alloy, offering the advantages of light weight and ease of drilling and tapping. This rustless aluminum alloy is non-sparking . . . an important consideration for hazardous locations. The aluminum, too, will disperse heat better than most metals. (Bulletin F-254).

(15) Silent Chain

A new 88-page book, containing detailed engineering data, has been published by Link-Belt Co., dealing with silent chain. Pre-engineered stock drives for normal requirements are listed in one 16-page section. Another section of 22 pages outlines the procedure for selecting completely engineered drives. It includes a conveniently indexed table of service factors, rating tables, and chain length and center distance computations. A section on drive components lists available chain widths; chain and wheel dimensions; wheel tolerances, materials, and other pertinent data. The section on accessories covers casings and tensioners. Complete operational and technical data, such as installation, maintenance, and lubrication procedures, are described in the final section. (Book 2425).

(16) Thermistors

A new manual that enables a user to understand easily what Thermistors are, how they are applied, what functions they perform and what benefits industry derive from them in detecting and compensating temperatures, and providing time delay or surge control in electrical equipment. is announced by Carboloy Department of General Electric Co. The 52-page publication includes tests supplied by an independent laboratory, characteristic curves for a Thermistor carrying current in thermal equilibrium with the ambient, and for one where the time delay function is of primary interest. The manual provides considerable background information, since it covers applications, characteristics, explanations of the source and utility of the data as well as the curves, and other general information. Illustrations are keyed so a user can tell at a glance which style or type is best adapted to his application. (TH-13).

(17) Batch Process Controller

The Batch Stabilog controller, specially designed to prevent "overshoot" of a variable during the start-up of batch processes, is described in a technical report released by the Foxboro Co. The instrument can be used in controlling temperatures of repetitive operations such as carburizing, annealing, core baking, ceramic firing and similar work, if done on a batch basis. The report explains the controller in detail, with diagrams showing instrument circuitry and comparative responses of various control actions. (TI29-B-52a).

(18) Positioning Equipment

A new general catalog has just been announced by the Wilton Tool Mfg. Co. which describes their many types of vises, clamps and positioning devices. It contains such features as full page editorial index, cross-sectional drawings showing internal construction of various products, and cross-reference charts of competitive lines. Over 150 illustrations are used to make the catalog easier to read and more interesting. Not only

users of clamping and positioning tools, but also distributors who handle these products will find the catalog a valuable reference book. (Catalog 110).

(19) Pyrometer

For temperature measurement beyond 1000 F, a thermo-electric pyrometer is the most economical device giving precision results according to a bulletin published by Illinois Testing Laboratory. The bulletin is a concise discussion of pertinent facts about pyrometry in general industry. It discusses the many primary advantages of a pyrometer over other less sensitive temperature indicators.

(20) Work Rolls

The publication of a new technical bulletin is announced by the Metal Carbides Corp. Included in the bulletin is a description of the difference between grade A and grade B rolls, as well as a list of types of strip steel that can be satisfactorily rolled with grade B rolls and types of strip steel which require grade A rolls to obtain the proper finish. Other information regarding reduction per pass, service life per grind, mechanical and production advantages, are also covered. (Bulletin TB3).

(21) Metallurgical Furnaces

A new illustrated brochure on metallurgical furnaces, describing Rust Furnace Co.'s services to industry as designer-constructor of all types of fuel-fired furnaces in the melting, reheating and heat treating fields, is now available. Many types of industrial furnaces are depicted in the 24-page brochure.

(22) Vibration Measuring Instrument

Now available from Epic, Inc., is a leaflet on a new vibration measuring instrument manufactured by Askania-Werke. The leaflet describes the instrument's many accessories which enable it to be used not only to measure longitudinal vibrations but also torsional vibrations on shafts, and even pressure vibrations on liquid or gas-carrying pipes.

(23) Automatic Pump Sequence Control Systems

An improved automatic system for varying the number of pumps needed to satisfy fluctuating demands in multiple pump installations is described and illustrated in a four-page catalog from Fischer & Porter Co. The principle of kinetic manometry — direct measurement of a constant percentage of main-line flow through an orifice and taps — is used to actuate a float with an armature attached. Changes in main-line flow move the float up or down causing armature movement through the electro-magnet field of one or more inductance coils. This inductance change is transposed electronically to an electric signal that either stops or starts — depending on direction of change — the pump corresponding to the coil through which the armature has moved. (Catalog 91-106).

(24) Crane Cab Cooler

A new 1954 booklet on how to air condition crane cabs successfully and showing the complete line of Aire-Rectifiers is announced by the Lintern Corp. It describes many features claimed to be exclusive in this field and as contributing to low cost operation and low maintenance. With this booklet, the prospective user can select the right model for the particular temperature range of the crane in mind. Accompanying the description is a chart of applications (type of crane operation) temperatures encountered, and model recommended for the particular conditions. By selecting the air conditioner of the proper size for the job, substantial savings are possible as compared with buying a unit designed for high temperature ranges when one for lower temperatures would answer the purpose satisfactorily. (Bulletin AC 544).

(25) Electric-Weld Pipe Mills

Now available from Yoder Co. is a booklet dealing with electric-weld pipe mills. It includes graphs and statistical summaries on pipe consumption in U.S.A. since 1915, with breakdowns by classes as well as by methods of manufacture. A description of resistance-weld mills includes chapters on tube forming, systems of roll designs, edge conditioning, high and low cold-roll forming limits, tooling for pipe making, development of resistance welders, weld controls and power consumption. A brief review of ASTM and API specifications for line pipe, oil country tubular goods, mechanical tubing, boiler tubes and standard pipe is also presented, together with numerous photographs of mill installations.

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50	AMERICAN BRIDGE CO., DIVISION U. S. STEEL CORP.		New catalog on Heroult electric melting furnaces.
51	AMERICAN WHEELABRATOR & EQUIPMENT CORP.	BULLETINS 894 & 914	Details on descaling strip and sheet mechanically.
52	E. W. BLISS CO.	BULLETIN 40-A	60 page rolling mill brochure.
53	BRISTOL CO.	BOOKLET P1245	Complete story on Dynamaster.
54	CLARK EQUIPMENT CO.		Literature on new Powrworker truck.
55	CLEVELAND WORM & GEAR CO.	CATALOG 400	New catalog on worm gears.
56	DE LAVAL SEPARATOR CO.	BULLETIN 500	Information on steel mill lubrication systems.
57	DIAMOND POWER SPECIALTY CORP.	BULLETIN 1136	Shows how wired television can be used in industrial operations.
58	DRAVO CORP.	BULLETIN ZA-1301-02	Information on split-type and self-contained crane cab coolers.
59	DREVER CO.	BULLETIN B-90	Bulletin on roller-hearth furnaces.
60	DURALOY CO.	BULLETIN 4-DU-8	Details on high alloy castings.
61	ELECTRIC CONTROLLER & MFG. CO.	BULLETIN 942-B	Complete data on Tab-weld resistors.
62	ELECTRIC CONTROLLER & MFG. CO.	BULLETIN 1032	Illustrated description of safety limit stops.
63	ELECTRIC CONTROLLER & MFG. CO.	BOOKLET 1041	Specifications for Neo-time-current method of acceleration.
64	ENTERPRISE CO.	BULLETIN 501	Details on roller conveyor units.
65	FARREL-BIRMINGHAM CO., INC.	BULLETIN 115	Description of heavy duty roll grinder.
66	D. B. FLOWER MFG. CO.	CATALOG 41	Data on precision engineered brush holders.
67	FOXBORO CO.	BULLETIN 407 & DATA SHEET 330-1	Information on moisture control for furnace air blast.
68	GENERAL ELECTRIC CO.	BULLETIN GEA-4654	Information on armored motor with exclusive armature design.
69	GENERAL MOTORS CORP., HYATT BEARINGS DIV.	CATALOG 150	General catalog on roller bearings.
70	HARNISCHFEGER CORP.	BULLETIN C-42	Details on mill type cranes.
71	C. B. HUNT & SON, INC.		Descriptive data sheets on control valves.
72	JOHNS-MANVILLE SALES CORP.	BOOKLET IN-115A	Description of insulating brick.
73	JOHNS-MANVILLE SALES CORP.	BROCHURE PK-46A	Details on clipper seals.
74	KAISER ALUMINUM & CHEMICAL SALES, INC.		Descriptive literature on refractory brick and ramming materials.
75	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Catalog on Fast's couplings.
76	LEEDS & NORTHRUP CO.	DATA SHEET 643(1)	Details on thermocouples.
77	McDANEL REFRACTORY PORCELAIN CO.		Catalog on industrial porcelains.
78	MINNEAPOLIS-HONEYWELL REGULATOR CO.	CATALOG 1531 & DATA SHEET 6.4-11	Details on ElectriK controllers and faster heat-up for furnaces.
79	OKONITE CO.	BULLETIN IS-1075	New manual on use of rubber-insulated cable.
80	PENNSYLVANIA TRANSFORMER CO.	BULLETIN 951	Information on class H transformers.
81	PITTSBURGH LECTROMELT FURNACE CORP.	CATALOG 8	Details on Lectromelt electric arc furnaces.
82	PLASTEEL PRODUCTS CORP.		Engineer's handbook on use of Plasteel insulated panels.
83	POST-GLOVER ELECTRIC CO.	BULLETIN 500	Detailed information on limit switch resistors.
84	RADIO CORP. OF AMERICA		Booklet on RCA industrial TV.
85	RAMTITE CO.		Steel plant furnace bulletin.
86	RAMTITE CO.		Castable and gunning refractories bulletin.
87	RUST FURNACE CO.		24 pages of furnace information.
88	RUST-OLEUM CORP.		Literature and color chart on Rust-Oleum.
89	S. G. TAYLOR CHAIN CO.	BOOKLET 12C	Facts and specifications on alloy steel chain.
90	UNION CARBIDE & CARBON CORP., NATIONAL CARBON CO.	CATALOG S-6210	Refractories catalog.
91	UNITED STATES GRAPHITE CO.		Complete brush catalog.
92	WAGNER ELECTRIC CORP.	BULLETINS TU-56 & TU-13	Full information on dry-type and liquid-filled transformers.
93	L. J. WING MFG. CO.	BULLETIN HR-6	Details on revolving heaters for industrial plants.
94	YODER CO.		Discussion of economics and mechanics of slitter operation.

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1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

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93	94															

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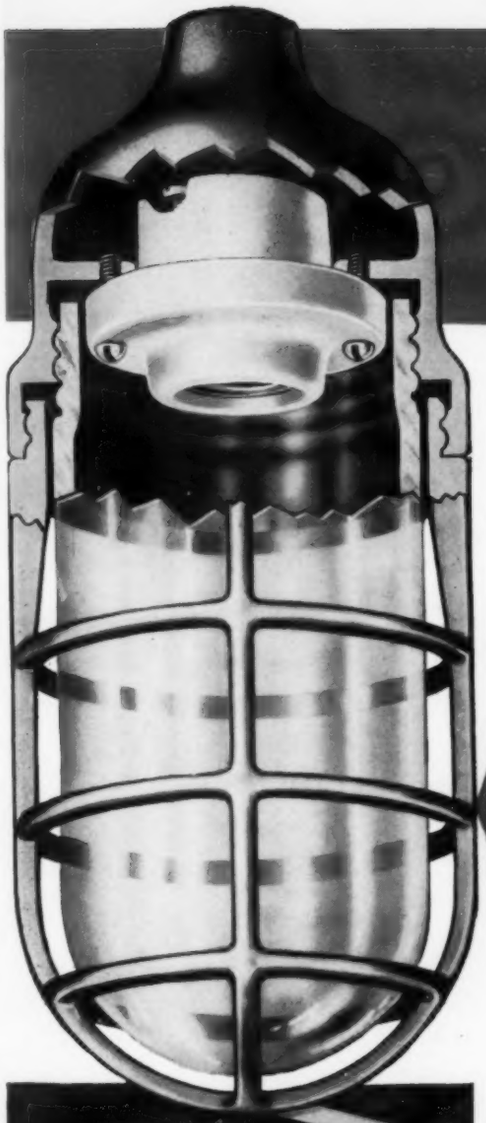
CROUSE-HINDS

Vaportight

Industrial Lighting Fixtures



For use in boiler rooms, powerhouses, shower rooms, tunnels, loading docks, building entrances, and all indoor and outdoor locations where exposed to moisture and rain, non-explosive vapors and gases, or non-combustible dusts.

1. **Vaportight** and raintight.
2. **Wiring chamber** remains vaportight even though globe is off.
3. **Porcelain Receptacle.**
4. **Screw guard** or clamp guard.
5. **11 Hub** arrangements.
6. **4 Reflector** styles.
7. **Accessories:** Colored globes, pear-shaped globes and guards, half shades, and adapters.
8. **4 Sizes:** 50 through 500-Watt.

Vaportight lighting fixtures are available for attaching to several round-base Condulets and sheet steel outlet boxes. Crouse-Hinds complete *Vaportight* line includes hand lamps, switches, plug receptacles, and other electrical devices.

Complete listings in the Condulet Catalog.

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS
FLOODLIGHTS
TRAFFIC SIGNALS
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CROUSE-HINDS COMPANY
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OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston Indianapolis — Kansas City — Los Angles — Milwaukee — Minneapolis — New Orleans — New York — Philadelphia Pittsburgh — Portland, Ore. — San Francisco — Seattle — St. Louis — Tulsa — Washington.
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Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

UNLOADERS and BRIDGES
for Ore...Limestone...Coal

These three towers, located at a large steel plant in Detroit, provide an impressive illustration of the effective design and sturdy construction of Mead-Morrison equipment. The latest addition to this team of unloaders, the tower in the foreground, is provided with a rotating bucket and a belt conveyor which carries ore from hopper back to trough, making possible an unloading rate of 2000 tons per hour.

From the trough, the ore and limestone is rehandled by Mead-Morrison bridges to the storage pile and the high line feeding the blast furnaces.

Design features in these machines make them outstanding in ease of operation and smoothness of control. Be sure to consult Mead-Morrison on your material unloading and rehandling problems.

MEAD-MORRISON

Division of **McKIERNAN-TERRY CORPORATION** · *Manufacturing Engineers*

HARRISON, NEW JERSEY

MK 801

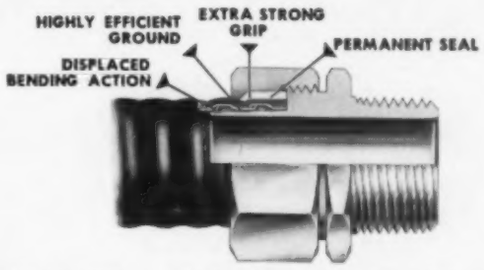
"MULTICUT"
Shear Blades - Rotary Knives
by
WAPAKONETA

"TUFFCUT"
"HOT WORK"
"LAID HIGH SPEED"
and "MULTICUT"
are all made by
Wapakoneta
and
ENGINEERED
TO THE JOB

Complete records with order number of each blade makes possible duplication of exact size and temper at any time.

SINCE 1891
THE WAPAKONETA MACHINE CO.
WAPAKONETA, OHIO

it's new— an improved connector for liquid-tight flexible conduit (Sealtite or equivalent products)



PYLE-NATIONAL

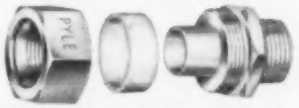
"CT" series Connectors offer all these advantages

EXTRA STRONG GRIP
- Compression force applied against body shank—not against the conduit alone, making a vise-like clamp.
- Plastic-to-plastic grip with the conduit sheath avoids cutting and abrasion

PERMANENT SEAL
- Plastic Sleeve and Conduit Sheath have equal physical characteristics. The seal will last the life of the conduit.

HIGHLY EFFICIENT GROUND
- Less than 10 millivolt drop.

DISPLACED BENDING ACTION
- Tapered body shank extends beyond gland nut, preventing short radius bends, lengthening life of conduit sheath and permanency of joint.



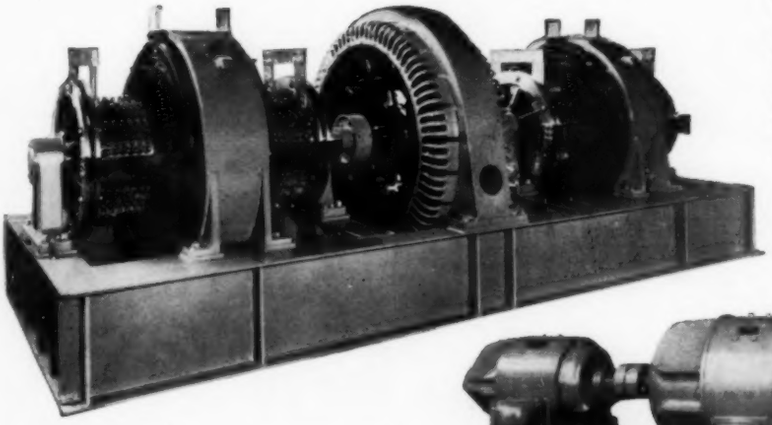
"CT" series connectors can be installed assembled. Available in Straight, 45° and 90° types for ⅜" to 2" conduit. Meet U/L and J.I.C. standards.

SINCE 1897
THE PYLE-NATIONAL COMPANY
1383 North Kostner Avenue Chicago 51, Illinois

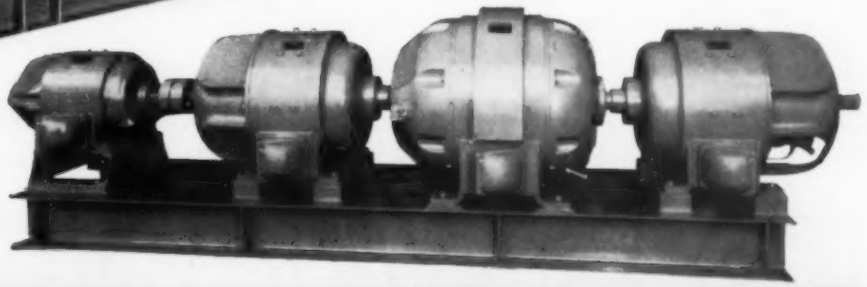
COLUMBIA

MOTOR GENERATORS

Whether it be for continuous electrolytic tin-plating or electrocleaning lines, or for special power needs, Columbia builds Motor Generator Sets for your individual requirements. They're giving superior, around-the-clock performance in many of the country's leading mills. Illustrated here are typical installations of Columbia generators built to specification.

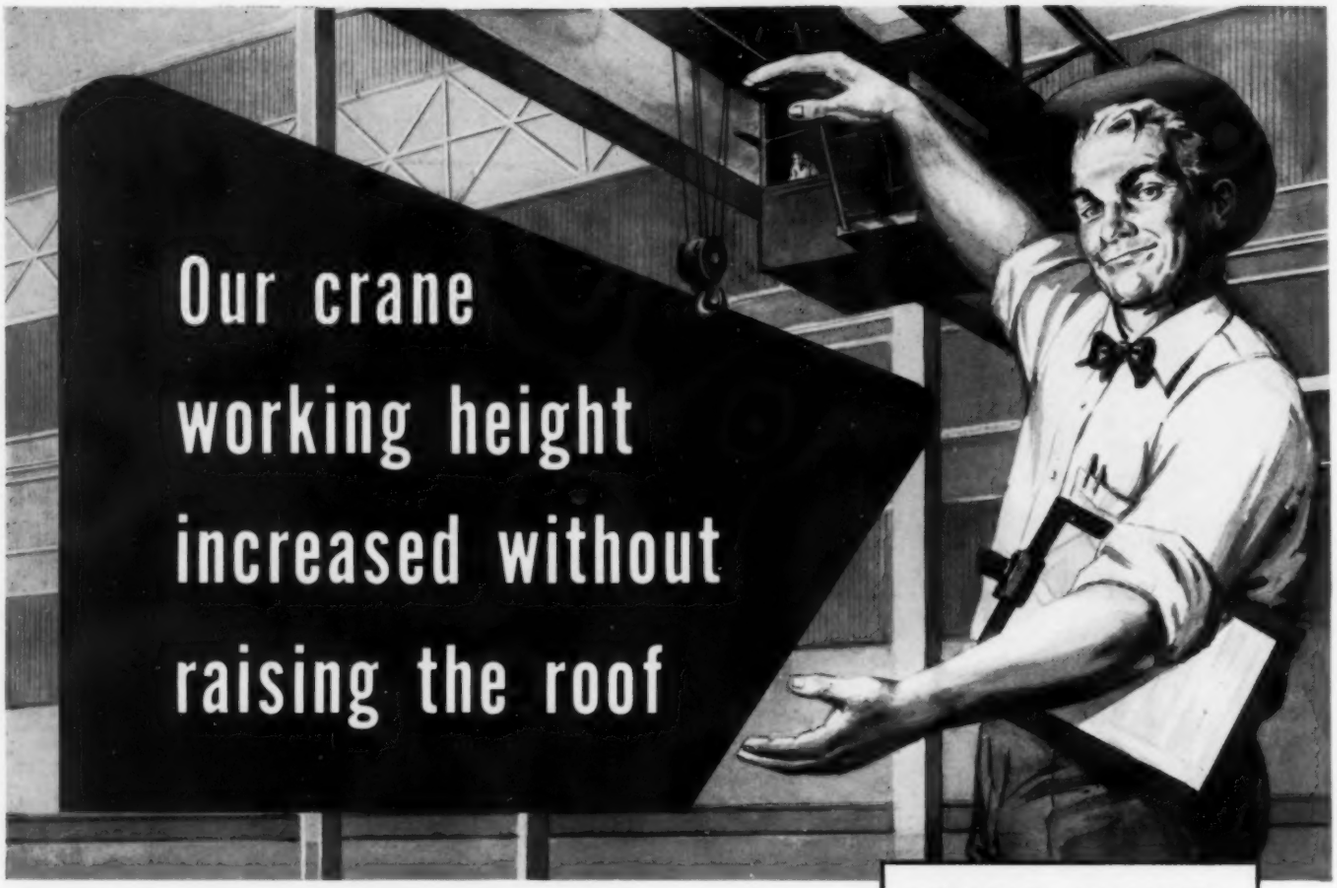


Two 7500 Ampere 24 volt, 3750 Ampere 48 volt, Separately Excited, Columbia D.C. Generators driven by 600 HP, 1.OPF, 360 RPM Synchronous Motor.



Multi-Unit Columbia Motor Generator Set consisting of two 50 KW, 250 Volt, D. C. Generators, and one 10 KW, 50 Volt, 200 Ampere booster Generator, all driven by 200 HP, 0.8PF, 1200 RPM Synchronous Motor.

COLUMBIA ELECTRIC MFG. COMPANY
4543 Hamilton Avenue Cleveland 14, Ohio



WITH EC&M YOUNGSTOWN SAFETY LIMIT STOPS

"We frequently needed more headroom on our D-c cranes. The limit stop setting couldn't be raised without sacrificing the clearance needed by the hoist-brake to safely stop the fast-moving empty hook, which hoists 2½ to 3 times faster than when hoisting full load. We had a choice . . . we could raise the roof . . . which meant deeper footings, heavier building columns and increased costs for lighting, heating and ventilating . . . OR . . . we could equip our cranes with **quick-stopping** EC&M Youngstown Safety Limit Stops."

Yes, Youngstown Hoist Limit Stops not only disconnect power from the motor but also apply **dynamic braking** to aid the hoist-brake in a **quick stop** . . . giving less drift . . . more headroom. **Safe,** too, because the tripping point does not change . . . is not affected by stretching of the hoist cables. The point at which the rising crane-hook makes contact to lift the Youngstown suspended-weight always remains the same.

For increased D-c crane headroom, **plus safety,** investigate EC&M Youngstown Safety Limit Stops.

QUICK-STOPPING type of LIMIT STOP gives MINIMUM DRIFT
CIRCUIT-OPENING type of LIMIT SWITCH requires GREATER CLEARANCE FOR DRIFT
THIS SPACE SAVED

Write today for Bulletin 1032 which describes and illustrates EC&M Youngstown Limit Stops.

1775

YOU CAN LIFT LOADS HIGHER AND SAFER WITH EC&M YOUNGSTOWN SAFETY LIMIT STOPS

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Reduce

HOT STRIP RUN-OUT TABLE Maintenance

with F&Y

Ductile Cast Iron ROLLS

Resist Heat Check and Warpage
Exceptionally Good Under the Sprays

We invite your inquiries on table rolls or any other ductile cast iron castings up to 100,000 pounds.

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

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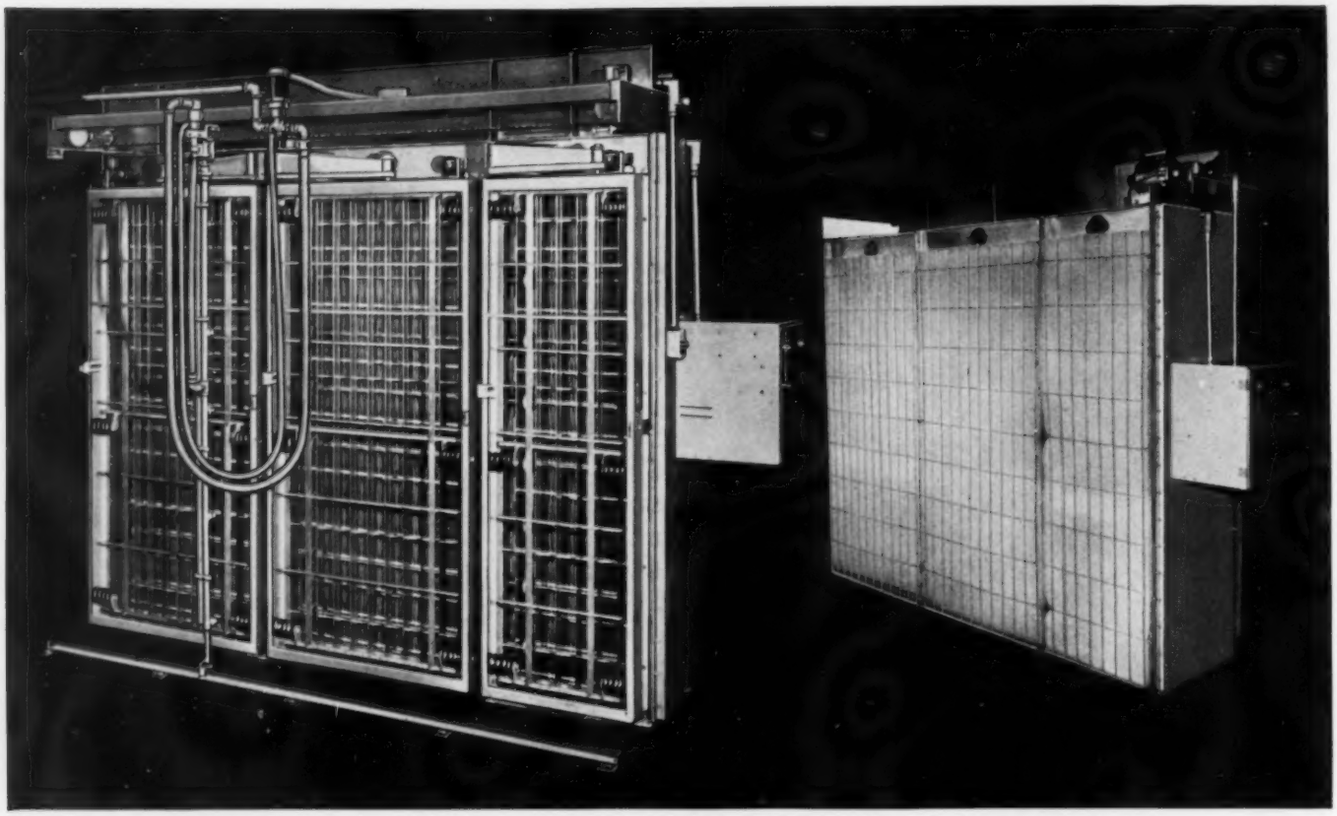
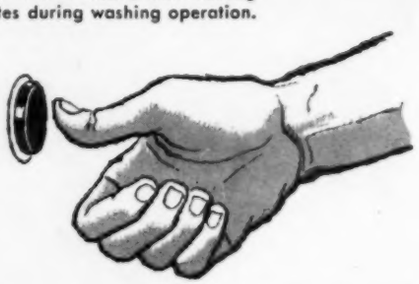


New Type "H" Washer incorporated as an integral part of the Electro-Cell precipitator. Spray nozzles for both the washing and collector plate coating operations travel on an overhead trackway. RIGHT: Rear view of Electro-Cell showing water eliminators consisting of Amer-glas pads which catch any surplus spray escaping plates during washing operation.

PUSH-BUTTON MAINTENANCE IS HERE!



AAF Electro-Cell Precipitator with Type "H" Washer cleans both the air *and itself* automatically

Clean air around the clock for mill motors, switch gear and rectifier room ventilation! Dust, soot and even smoke are "easy pickin's" for the high efficiency AAF Electro-Cell electronic precipitator. Now, with the addition of the new Type "H" Washer, that periodic cleaning operation (so essential to continued efficiency) is reduced to a mere push of a button.

Easy? Let's push the button and see what happens. First, the spray header moves back and forth across the face of the plate cells, washing away the accumulated dust and dirt. After a five-minute drying period, an adhesive coating is then applied to the clean collector plates through another set of spray nozzles mounted on the traveling header. Each operation is automatically timed. There's no opening and closing of valves or clock watching on your part. That one press of the button did the complete cleaning job.

It's a thorough job, too, because the spray heads are automatically adjusted to always point at a 5-degree angle in the direction they are traveling. Each side of each individual plate receives a thorough washing and even application of adhesive over its entire depth.

A high efficiency precipitator with a dependable, always available maintenance crew "built-in"—that's the AAF Electro-Cell with Type "H" Washer. For complete product information, call your local AAF representative or write direct.

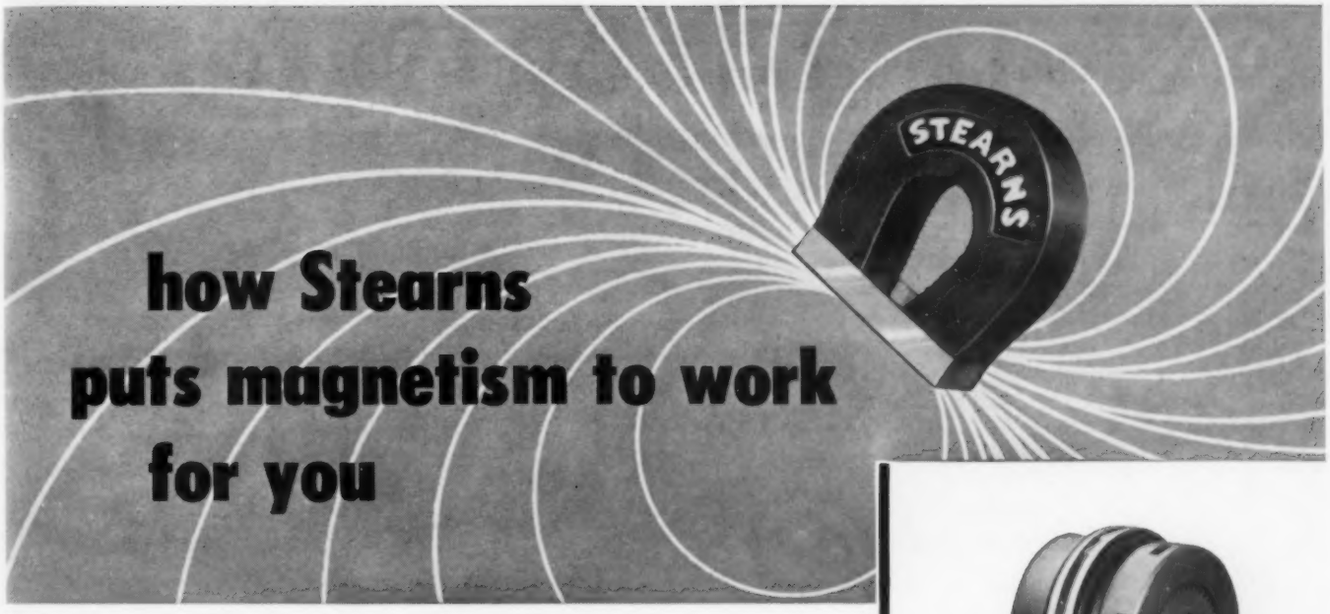
AAF

American Air Filter

COMPANY, INC.

302 Central Avenue, Louisville 8, Kentucky

American Air Filter of Canada, Ltd., Montreal, P. Q.

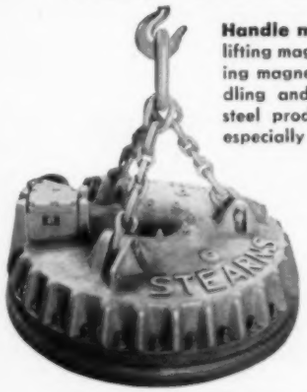


how Stearns puts magnetism to work for you

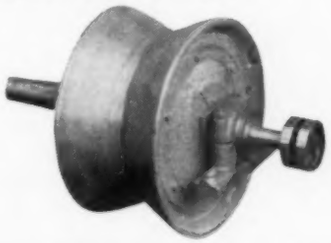
The horizons for new and varied uses for the power of magnetism seem almost limitless. Stearns Magnetic, Inc., a pioneer in the research and development of magnetic products for industry, is constantly studying new ways to put this dynamic force to profitable use.

Basically, Stearns products and research are pointed to help industry to do these four important jobs better and at lower cost —

Transmit power — Magnetic brakes, clutches and clutch-brake combinations built by Stearns in either standard or made-to-order models are used on hundreds of different types of products and equipment from business machines to steel mill screw-downs.



Handle materials — Stearns circular and rectangular lifting magnets, pipe and sheet metal rolls, grinder holding magnets and magnetic parts separators speed handling and assembling of a wide range of iron and steel products. Stearns circular lifting magnets, built especially for steel mill use, are the world's largest.



Protect plant and machinery — Stearns magnetic pulleys and suspended separation magnets remove harmful tramp iron — protect expensive crushers—help prevent spark-induced explosions.

Stearns maintains a fully-equipped laboratory to help you solve your problems — the modern, magnetic way. We welcome the opportunity to serve you. Requests for literature or special information receive immediate attention. Write today.

1081

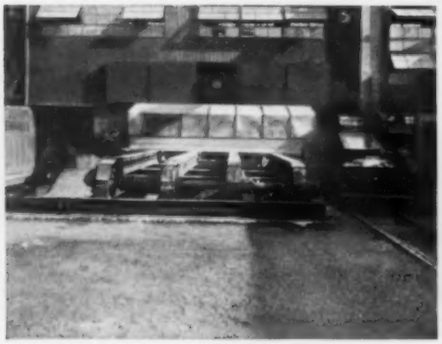
Purify products — Stearns gravity induction, cross belt, and heavy media separators purify products by separating magnetic from non-magnetic materials — purify foundry sands, etc. — profitably separate magnetic concentrates from low-grade ore.

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

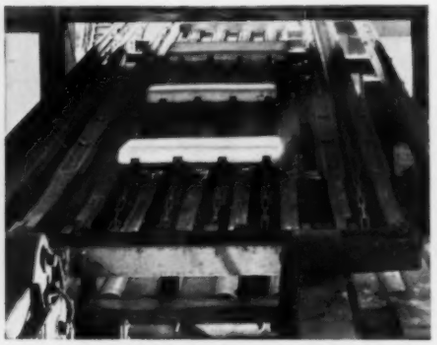
STEARNS MAGNETS

STEARNS MAGNETIC, INC. • 681 S. 28TH ST., MILWAUKEE 46, WIS.

How LINK-BELT helps cut costs of handling steel in every form



SLABS—Up to 70 tons of hot slabs are easily carried by 4-strand chain conveyor.



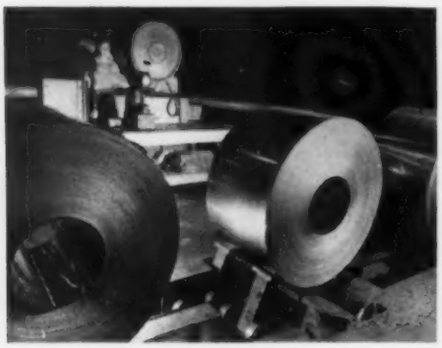
BILLETS—Dependable Link-Belt chain with pusher attachments transfers steel billets.

PLATES are transferred from hot run to cold run tables on 51 strands of steel chain.

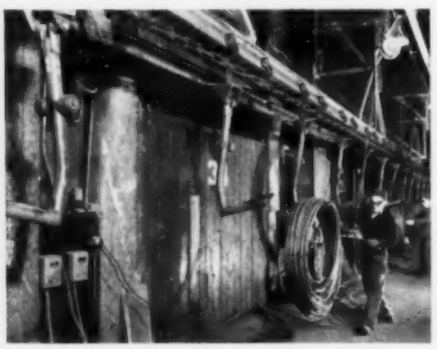
TUBES—12 endless strands of Class H pintle chain serve this modern pipe cooling rack.

SKELP—Hot skelp moves to the reels on a Link-Belt steel apron conveyor 108 in. wide.

SCRAP—At this mill, scrap is handled on a completely mechanized Link-Belt system.



COILS—Up to 75,000-lb. coils are carried on Link-Belt conveyors—gently, safely.



ROD COILS—Coils are tied as they move on 850-ft. Link-Belt overhead trolley conveyor.

MILL SCALE recovery was boosted from 250 to 475 tons a week by Straightline Collectors.

FOR every step of your steel handling, Link-Belt conveyors offer many real economies.

- First, you can step up capacity with mechanization that eliminates many rehandling bottlenecks.
- Second, more efficient handling methods cut costs by releasing valuable manpower for other work.
- Third, you'll find waste goes down and yield up because mechanization minimizes the chances of careless handling.
- Last, but not least, safety is improved. No confusing cross traffic. Workers can be kept clear of hazardous locations.

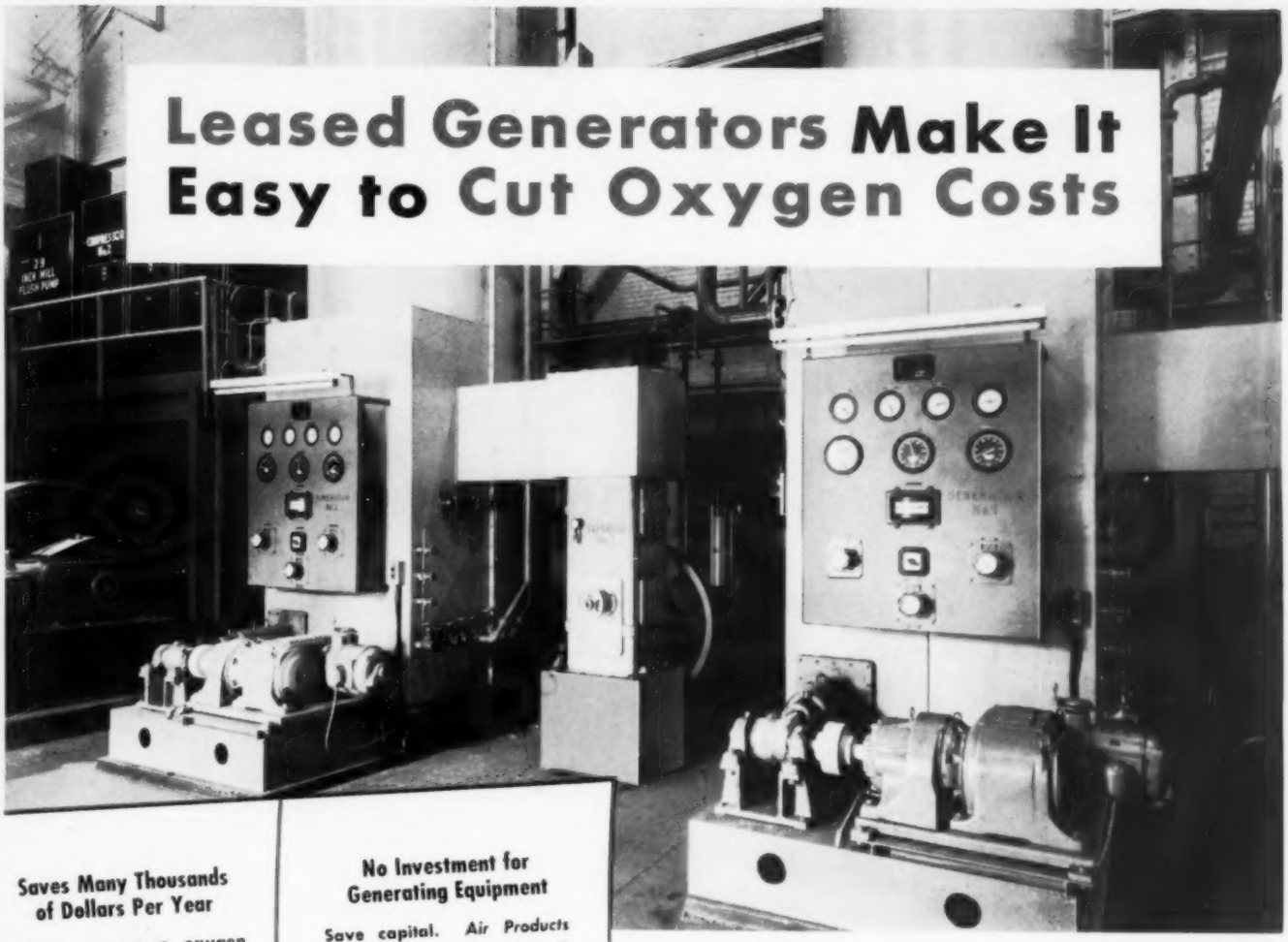
Remember, Link-Belt builds a complete line of conveying equipment, can help you get the type best-suited to your overall system requirements. For expert engineering cooperation, call your nearby Link-Belt salesman today.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,470

Leased Generators Make It Easy to Cut Oxygen Costs



Saves Many Thousands of Dollars Per Year

Making your own oxygen eliminates transportation costs and costs of getting oxygen into and out of containers.

No Investment for Generating Equipment

Save capital. *Air Products* furnishes at its expense all equipment for a complete oxygen generating station.

Lease Payments 100% Tax Deductible

You cut oxygen costs... benefit further by paying for the use of the equipment with 100% tax deductible dollars.

Flexibility to Meet Changing Requirements

Fluctuating demands easily satisfied. Multiples of "package" generators furnished—each independent, complete.

Easy to Operate

Equipment is simple—easily operated by anyone who can run an air compressor. Part-time labor is adequate in many cases.

Maintenance Service

Parts are supplied at *Air Products'* expense. Stocked at site and at factories. *Preventive maintenance* provided on scheduled basis.

Some major Companies That Lease *Air Products* Oxygen Generators

American Chain & Cable Co., Inc.
Libbey-Owens-Ford Glass Co.
Copperweld Steel Co.
Granite City Steel Co.
National Steel Corp. (Weirton Steel Company)
Pittsburgh Steel Foundry Corp.

If you use over 500,000 cubic feet of oxygen per month you can slash costs—with no investment for generating equipment—by *leasing* an *Air Products* Oxygen Generator Installation.

Besides saving many thousands of dollars every year, you will gain control of your oxygen supply—free your company from costly interruptions due to transportation difficulties, failures in suppliers' plants, strikes.

Your installation will be made up of standard units selected from 12 *proven* models. And, if you need inert gas, these generators can be adapted to also produce large quantities of high-purity NITROGEN.

You make the savings—*Air Products* puts up the capital. Performance and dependability are assured by *Air Products'* maintenance service organization. Let us give you the details! *Air Products, Incorporated, Dept. P, Box 538, Allentown, Pa.*

Air Products
INCORPORATED

OXYGEN GENERATOR LEASE INSTALLATIONS

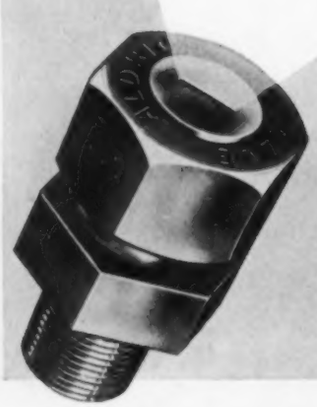
Also TONNAGE Oxygen-Nitrogen Generators

hot strip and billet *Descaling...* the Aldrich way

Aldrich Spray Nozzles for knife-edged cutting water

Effective descaling may mean the difference between a quality product and one that is not. Whether used for hydraulic descaling of billets, sheets, plates, or small parts—*Aldrich Descaling Systems* insure quick, thorough results.

Aldrich Direct Flow Pumps supply the high water pressures that do the job. *Aldrich Spray Nozzles* produce the solid, compact, knife-like spray pattern that breaks up scale and carries it away. The impinging force is equal to 95% of the potential energy supplied to the nozzle orifice . . . high efficiency with less water, no excessive cooling here!



A replaceable disc arrangement insures ease of maintenance and simplicity of repair. Aldrich discs are made of hardened stainless steel, machine ground to uniform contour. Profiling and burnishing to a polished finish remove the slightest imperfection on the orifice. Every Aldrich disc is hydraulically tested for uniform pattern and force.

For Spray Nozzles—or complete Descaling Systems—call on Aldrich.

the ALDRICH *pump company*

21 PINE STREET • ALLENTOWN, PENNSYLVANIA

. . . Originators of the Direct Flow Pump

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Carmi, Illinois • Charleston, W. Va. • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Duluth Houston • Los Angeles • New York • Oakland, Calif. • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • Rochester • Salt Lake City • San Francisco • Seattle Somerville, Mass. • Spokane, Wash. • Syracuse • Tulsa • Washington, D. C. • Youngstown • Export: Petroleum Machinery Corp., 30 Rockefeller Plaza, New York 20, N. Y.

Amazingly simple way to measure BLAST AIR DEW POINT

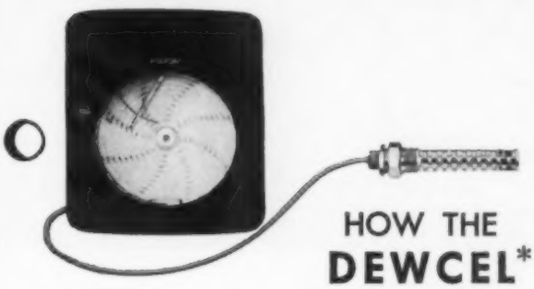
directly . . . accurately . . . continuously

Now you can measure or control the moisture content of blast air with simplicity and accuracy never before obtainable!

The unique Foxboro Dewcel*, an entirely new type humidity-sensitive element, has made this possible, at surprisingly low cost. Coupled with a Foxboro Recorder or Controller, the Dewcel offers these outstanding advantages:

1. Direct recording in dew point temperature, at existing pressure.
2. Wide working range — even operates at sub-zero temperatures.
3. Neither adds nor removes water from atmosphere.
4. No water box or circulation of air required.
5. Simplicity that eliminates maintenance.
6. High sustained accuracy.
7. Initial and operating economy.

Investigate Foxboro Dew Point Control. Write for Bulletin 407, and for Engineering Data Sheet 330-1 covering moisture control for furnace air blast. Foxboro Engineers will be glad to discuss the application **The Foxboro Company, 584 Neponset Avenue, Foxboro, Mass., U.S.A.**



HOW THE DEWCEL* WORKS

The Dewcel element is a thermometer bulb (liquid-filled or electric-resistance type) jacketed with lithium-chloride-impregnated woven glass tape. Over this are wound two spaced gold or silver wires connected to an AC source. The lithium chloride absorbs moisture, allowing current to flow, generating heat, and raising the temperature. Equilibrium temperature is reached when vapor-pressure of the moist salt exactly balances that of the surrounding air or gas. The System translates this temperature into direct readings of dew point.

Thus, Foxboro Dew Point Instruments give direct readings or control of dew point from —50°F. to 142°F. at working temperatures from —40°F. to 220°F. Readings easily converted to absolute or relative humidity.

*Trade Mark

FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

cuts hot steel slabs up to 7" thick by 42" wide

With a maximum knife pressure of 2,200,000 pounds and a combined stroke of 13 inches, this new Lewis up-and-down cut Shear has the capacity to cut hot steel slabs up to 7 inches x 42 inches. The knives are made of special shear knife steel . . . hardened and ground to withstand the terrific pressure. At continuous running speed, driven by a 250 hp motor, this big slab shear can make twelve cuts per minute.

At any time convenient to you, we'll be glad to give you more information on the design and specifications of our Lewis Slab Shear. And, of course, our experienced engineers and modern manufacturing facilities are always available to help you with any problem involving rolling mill machinery.

new LEWIS up-and-down cut SLAB SHEAR

BLAW-KNOX COMPANY · LEWIS MACHINERY DIVISION
PITTSBURGH 22, PENNSYLVANIA

BLAW-KNOX

LEWIS PRODUCTS: Two-High Mills • Three-High Mills • Four-High Mills • Bar, Billet and Structural Mills
Rod Mills • Coilers • Tables • Shears • Levelers • Pinion Stands • Gear Drives • Roll Lathes • Flaking Mills

Equipment News...

IGNITRON

▲ Available from Westinghouse Electric Corp. is a new model ignitron which provides for thermostatic control of cooling water. Thermostatic control reduces cooling water consumption and provides protection to the tube and associated equipment in case of water failure.

The ignitron, WL-5551-A, is a sealed, stainless-steel jacketed, water-cooled, mercury-pool tube. It is capable of replacing the standard model WL-5551 directly, with the advantage of provision for suitable thermostatic control. A suitably calibrated thermostat, attached to the mount provided on the side of the tube, may be used to stop tube operation in case of insufficient water flow, or may be used with a solenoid water valve to turn cooling water on and off as needed.

The tube is designed primarily for resistance welding control. Two tubes normally used with single-phase welders will control 600 kva at 250 to 600 volts over a 25- to 60-cycle frequency range.

DISTILLER UNIT

▲ Ordinary tap water can be changed into the chemical equivalent of triple distilled water (in terms of specific resistance) for as little as ten cents a gallon with a new device announced by Central Scientific Co.

Called Quikpure, the device is comprised of a 16-oz polyethylene squeeze bottle, the bottom of which contains a mixture of cation and anion exchange resins. Tap water poured into the bottle comes into immediate contact with the resins and is converted to distilled water in about one minute.

A specially designed cap permits the user to discharge the distilled water from the squeeze bottle, but will not allow the resins to escape. They remain in the bottle and may be used repeatedly up to about 25 gallons of water, depending upon its hardness. When the resins cease to react, a color change occurs caused by the presence of a registered food, drug and cosmetic dye.

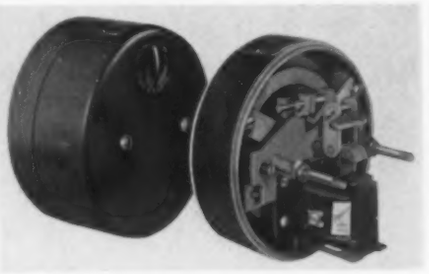
The monobed resin works as follows: cations, or positively charged particles, are exchanged for hydrogen ions; the anions, or negatively charged particles, are exchanged for the hydroxyl ions of the resin. The hydrogen and hydroxyl ions resulting from the two exchanges react almost instantly with each other to form H_20 and nothing else. Hence, the effluent from Quikpure must contain pure water.

Quikpure is said to provide greater control over the water produced than former methods which utilized a cartridge filter. Water can be forced too fast through a cartridge, allowing insufficient time for adequate ionic exchange. With Quikpure, however, the user can regulate the time of contact between resin and tap water until he obtains the desired chemical equivalent of single or triple distilled, or even higher. Higher than triple distilled water is obtained by longer than one minute contact with Quikpure.

BRAKES

▲ Introduction of a new line of magnetic disc brakes for FHP motors, is announced by Stearns Magnetic, Inc.

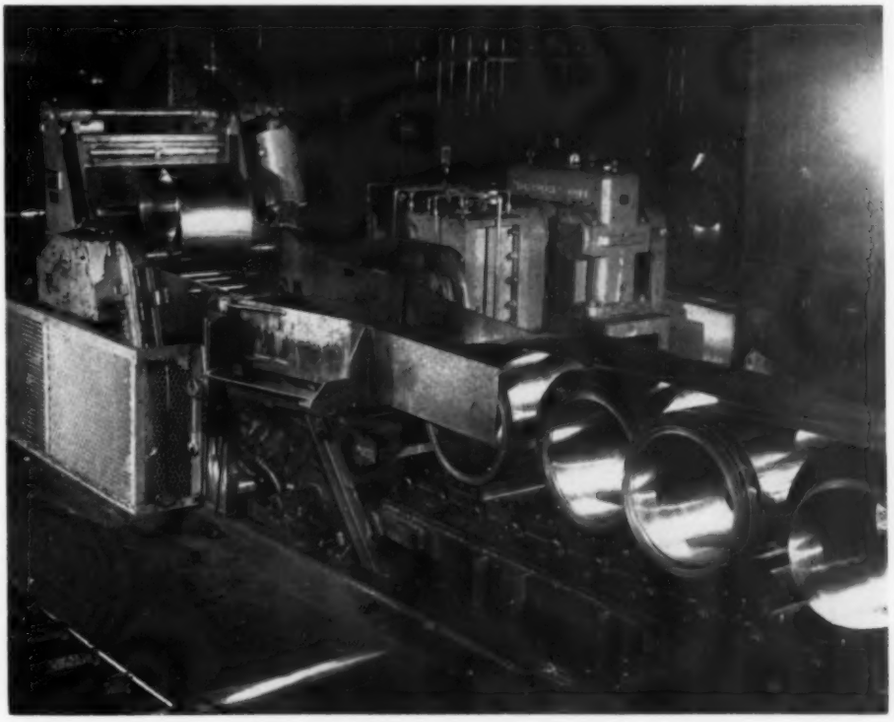
The 40 series brake is designed to



meet the new NEMA frame standards in the $\frac{1}{20}$ hp to $\frac{1}{3}$ hp range. It is only 5-in. in diameter, less than $3\frac{1}{2}$-in. long and has a torque range

UNCOILER IN OPERATION AT BRASS PLANT

Built by E. W. Bliss Co., Salem, Ohio, this three-roll pyramid type upcoiler installed at the Waterbury, Conn. plant, of American Brass Co., coils 0.400-in. gage brass and silver alloys in widths up to 25 in. The upcoiler replaced equipment which could not coil brass alloys heavier than 0.280-in. gage. This meant that long unwieldy bars — up to 30 ft — had to be carried back to the sticking side of the mill for additional passes. Its capacity ranges up to 0.4375-in. thickness and to widths of 28-in. on certain mild metals. A feature of the coiler is that it produces straight tails which serve as flat "sticking ends" to facilitate subsequent passing.



C&D BATTERIES—
FOR EXTRA WORK!

Last year, Kaiser Metal Products, Bristol, Pa., one of the country's leading producers of aircraft components, bathtubs, kitchen sinks and cabinets, used 50,000 tons of steel in turning out such products. To help handle the enormous quantities of parts and material required, Kaiser uses C&D Slyver-Clad* batteries to power many of the industrial trucks employed in its daily operation. For Kaiser, like hundreds of other major American companies, has found it pays to power with C&D Slyver-Clad batteries.

C&D Slyver-Clad batteries are approved as standard equipment by all electric truck manufacturers. For further information, write for catalogs.

*T.M. Reg.

C&D BATTERIES, INC.
of Conshohocken, Pa.
Manufacturers of Industrial Batteries since 1906
SALES AND SERVICE OFFICES
IN PRINCIPAL CITIES FROM COAST TO COAST

of from 6 lb in. to 1 lb ft. It is designed for mounting on the standard NEMA C and bell for motor frames 42-C and 48-C and is also available for floor mounting independent of motor.

The 50 Series brake is designed for re-rated NEMA frames in the 1/6 hp through 2 hp motor range. It is available in four torque ratings: 1½, 3, 6 and 9 lb ft. This brake is designed to mount on new fractional hp motor frames 56-C and 66-C and integral hp motor frames 182 and 184. It takes less than one-half the space previously required.

LIVE CENTER

▲ Extreme accuracy and load carrying capacity beyond most usual requirements are claimed for a new, medium priced live center introduced by Ideal Industries, Inc.

Known as the "Universal," the new live center is designed to meet production demands for closer tolerances. Because of its high-accuracy, high-load factors, it is said to offer all the advantages of live centers—high turning speeds, freedom from gouging, burning, chatter and center-point lubrication—for an unusually wide variety of jobs.

Eccentricity tolerance is limited to plus or minus .0001-in. through the use of twin, precision-type roller bearings which are pre-loaded after assembly. The point is then ground in its own bearings *after* it has been inserted into the live center. A double seal is used to insure maximum service life, with continuous accuracy. A stationary hycar sealing ring in an anodized aluminum cap keeps dirt and chips out. Grease is kept inside the center by a slinger rotating with the point.

The housing and all working parts are hardened and ground to provide extra durability. The live center is available with Morse Tapers from two to five for rotating speeds from 50-2000 rpm and maximum loads to 5200 lb.

UNIT-SUPPORTED BUS

▲ Capable of withstanding the high short circuit currents of modern power systems and having a margin for future system growth, a new unit-supported bus of the isolated phase design, has been announced by the General Electric Co. The bus is gen-

Precision Engineered for PEAK PERFORMANCE

FLOWER
BRUSH HOLDERS

- MORE THAN 1,000 TYPES AVAILABLE
- INDIVIDUALLY DESIGNED FOR SPECIAL APPLICATIONS

SPECIAL TANDEM GANG BRUSH HOLDER

YOUR FLOWER BRUSH HOLDERS OFFER THESE SPECIAL FEATURES

EXACT: engineered to your specifications for a rigidly constructed, long wearing BRUSH HOLDER.

ACCURATE: engineered to your needs for the accurate dimensions of the box interiors to persist for long periods of time.

RIGHT: engineered from design to manufacture for the special type of BRUSH HOLDER your specifications require.

CHECK FLOWER PRECISION ENGINEERED BRUSH HOLDERS NOW!

WRITE FOR CATALOG 41

FLOWER PHILADELPHIA SINCE 1909

D. B. FLOWER MFG. CO.

1217 Spring Garden Street, Phila. 23, Penna.

Johns-Manville announces the development of new **SIL-O-CEL 16L** *Insulating Fire Brick . . .*

Lompoc, California, where Johns-Manville mines and processes diatomaceous silica insulating materials

Combines outstanding physical and thermal properties for furnace service to 1600F

Check these properties of SIL-O-CEL 16L

Maximum service temperature	1600F, back-up or exposed
Approximate density	33-35 lb per cu ft
Transverse strength	60 psi
Cold crushing strength	350 psi
Linear shrinkage	0.7 percent at 1600F
Reversible thermal expansion	less than 0.1 percent at 1600F
Thermal conductivity (Btu in. per sq ft per F per hr at indicated mean temperatures)	0.92 at 500F 1.07 at 1000F 1.22 at 1500F

1—has less than 0.1% reversible thermal expansion at 1600F

2—provides high load-bearing strength

3—for direct exposure or back-up service

Here is a new development of Johns-Manville insulation and refractory research. Its exceptional characteristics provide important savings in furnace construction. Made of diatomaceous silica, Sil-O-Cel* 16L Insulating Brick is light in weight . . . has low thermal conductivity . . . high structural strength. And where furnace linings are subjected to severe heat shock or where high load-bearing properties are needed, Sil-O-Cel 16L offers outstanding performance.

Sil-O-Cel 16L is now available. Samples will be sent on request. Also available without obligation is Booklet IN-115A, which describes Sil-O-Cel 16L and other J-M Insulating Brick and Insulating Fire Brick for service to 3000F. Write Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Sil-O-Cel is a Johns-Manville registered trade mark

Replaces SIL-O-CEL Natural Brick

The development of Sil-O-Cel 16L Insulating Brick has resulted in the discontinuance of Sil-O-Cel Natural Brick. The outstanding properties of Sil-O-Cel 16L make it the ideal replacement for Sil-O-Cel Natural Brick for back-up use. In addition, the properties of Sil-O-Cel 16L Brick extend its use to exposed service applications.

JM

Johns-Manville *FIRST IN* INSULATION

MATERIALS · ENGINEERING · APPLICATION

to Build a Better LADLE*

* . . . this 285-ton Pollock Open Hearth Ladle is welded on a special positioner designed specifically for jobs like this. The ladle is placed on the rollers and revolved until the ladle is in the best possible position for "down-welding." Using the positioner results in better welds. A positioner for a 285-ton ladle is big . . . it has to be. But at Pollock, where thinking is as big as the job itself, huge machines are commonplace.

The William B. Pollock Company prides itself on being able to do the big jobs. It has the skilled men, the resourceful engineers and the special machines (as this positioner) that are needed to turn your biggest drawing board dreams for iron and steel making facilities into solid, practical realities. When you're thinking "big," think of The William B. Pollock Company . . . specialists in all matters and equipment pertaining to the manufacture of iron and steel.

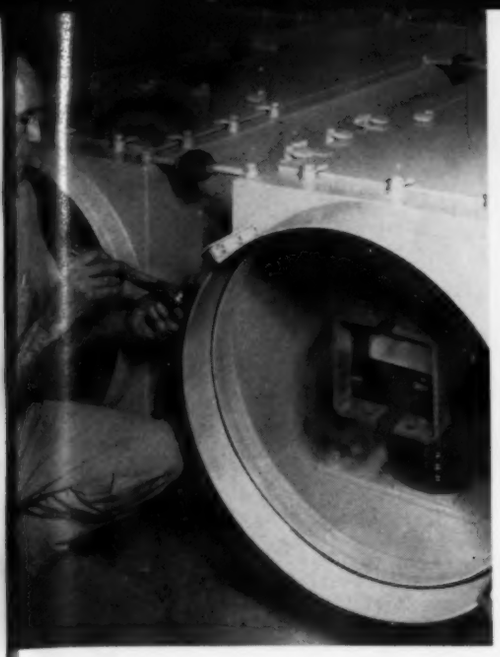
THE WILLIAM B. POLLOCK COMPANY

Since 1853

YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS

BLAST FURNACES • HOT METAL CARS AND LADLES • CINDER AND SLAG CARS • INGOT MOULD CARS • CHARGING BOX CARS • WELDED OPEN HEARTH LADLES



This unit-supported bus announced by the General Electric Co. weighs 13½ per cent less than present, typical three-phase sections and has single insulator supports. It is capable of withstanding the high short circuit currents of modern power systems and has a margin for future system growth.

erally used for direct connection of generators and main power transformers in a unit generation system.

Single insulator supports reduce the possibility of insulation failure and allows easier installation and maintenance than previous bus designs, according to G-E engineers.

Use of single supports was made possible because the metal sheath around the bus keeps the lines of force due to magnetic flux from acting between the conductors.

An area of "zero force" existing at the center of the enclosure, and conductors located at this point require a minimum of support.

Smaller covers with less gasketing area providing complete accessibility to insulator supports and connections; simplified hardware on covers for easier access to bus; a ground clip that slides back for testing without disassembly; and completely welded end bells for greater strength help simplify maintenance.

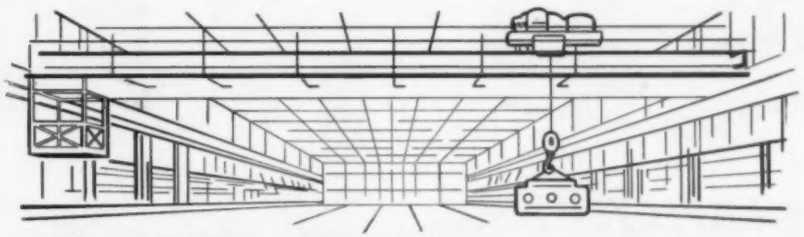
The new bus is available in lengths of three phase sections up to 16-ft and ratings up to 10,000 amps, 14.4 to 34.5-kv.

INSTRUMENT SYSTEM

▲ A new three-part pneumatically-operated instrument system known as the Metagraphic System, has been announced by the Bristol Co. In these instruments each of the basic functions performed is packaged separately. Units are: a transmitter, a receiver (recorder or indicator), and a controller. Each unit can be installed on the process at the point where it operates best, thus providing a high degree of flexibility of application.

Metagraphic instruments measure, indicate, record, and control pressure, vacuum, temperature, liquid level, differential pressure, and flow.

A universal 3-15 psi air pressure signal interconnects the three units no matter what variable is being transmitted. This makes the components universally interchangeable. (3 to 18 psi signal span also available.) The new receivers and controllers are designed for full plug-in service. Strip-chart recorders, and indicators are quickly interchangeable without loss of signal or control. Design features include continuous



CRANE BRAKE WHEELS

A variety of crane brake wheels made by Rosedale.

cast in MEEHANITE® metal by ROSEDALE

• resist distortion
• will not glaze

Crane brake wheels are expected to give good service and long life; early or unexpected failure is something which can't be allowed to happen. That's why several large steel producers regularly specify **Rosedale** Meehanite brake wheels.

Heavy duty wheels are cast in Meehanite metal and have a tensile strength over 55,000 psi. Long use has shown that these Meehanite wheels possess improved freedom from distortion (normally caused by severe usage) and that wheels will not glaze; consequently, constant gripping power is obtained. Wear is evenly distributed over the face as a result of completely uniform metal structure.

Crane brake wheels are only one of the many special types of castings produced by Rosedale for the steel industry which have outperformed all other competitive castings at many installations. If you have any problems involving the use of castings, regardless of application, contact Rosedale.

ROSEDALE FOUNDRY & MACHINE CO.

1731 Preble Avenue, Pittsburgh 33, Pa. • CEdar 1-4007

THE DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

AN EMPLOYEE WHO...

Requires no pay check
Never makes a mistake
Works 24 hours a day
Never takes a vacation

Many industrial operations that must be watched continuously and formerly required the individual attention of a man, are now being done without the man . . . by using a Diamond "Utiliscope" (Wired Television). The camera takes the place of the man . . . the monitor or receiver brings an exact picture of what is happening (as it happens) to a remote central control point or wherever else desired. Use the coupon below for further information.

TYPICAL USES

Checking remote gauge readings • Watching flow of molten steel • Viewing nuclear research • Observing conditions inside furnaces • Coordinating materials flow on conveyors. • "Utiliscope" (Reg. U.S. Pat. Office).

6700

DIAMOND POWER SPECIALTY CORP. E
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

Name_____

Company_____

Address_____

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited — Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment for Industry

valve position indication requiring no switching to get reading, "bumpless" manual-automatic transfer by simply matching pointers, and a set-point regulator of high-output capacity.

INDUCTION MOTORS

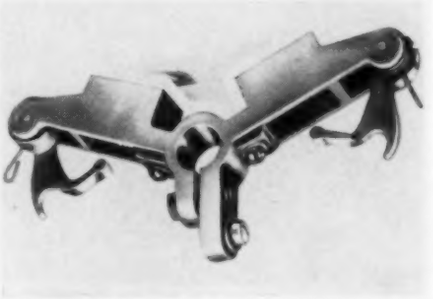
▲ Built by Electric Machinery Mfg. Co., a new line of squirrel-cage induction motors offers full protection against moisture and corrosion.

Called "Sil-Clad," these motors feature complete silicone insulation on the motor winding, silicone enamel baked on all exposed metal parts of the motor, and stainless steel on parts subject to air abrasion. It has excellent heat resistance, repels water is inert to corrosion from most airborne chemical fumes, resists oxidation and sunlight, and is a very good electrical insulator.

Available in ratings of 250-hp and larger, the motor is especially designed to provide protection in damp, moist, or steamy conditions, in sea coast locations subject to salt corrosion, in chemically active atmospheres or in other situations which induce deterioration by rusting, or moisture penetration.

The mechanical construction of the motor is such as to minimize entrance of air-borne dirt and particles.

BRUSH HOLDER



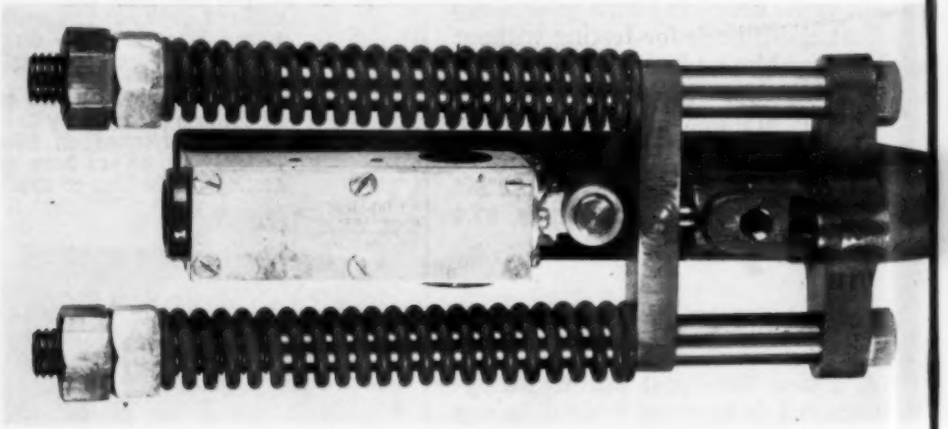
This tandem brush holder, product of D. B. Flower Mfg. Co., is newly designed for slip ring motors from 3-in. to 12-in. diameter ring with varied size mounting studs and various size brushes. It features bronze casting and adjustable spring tension for brush pressure.

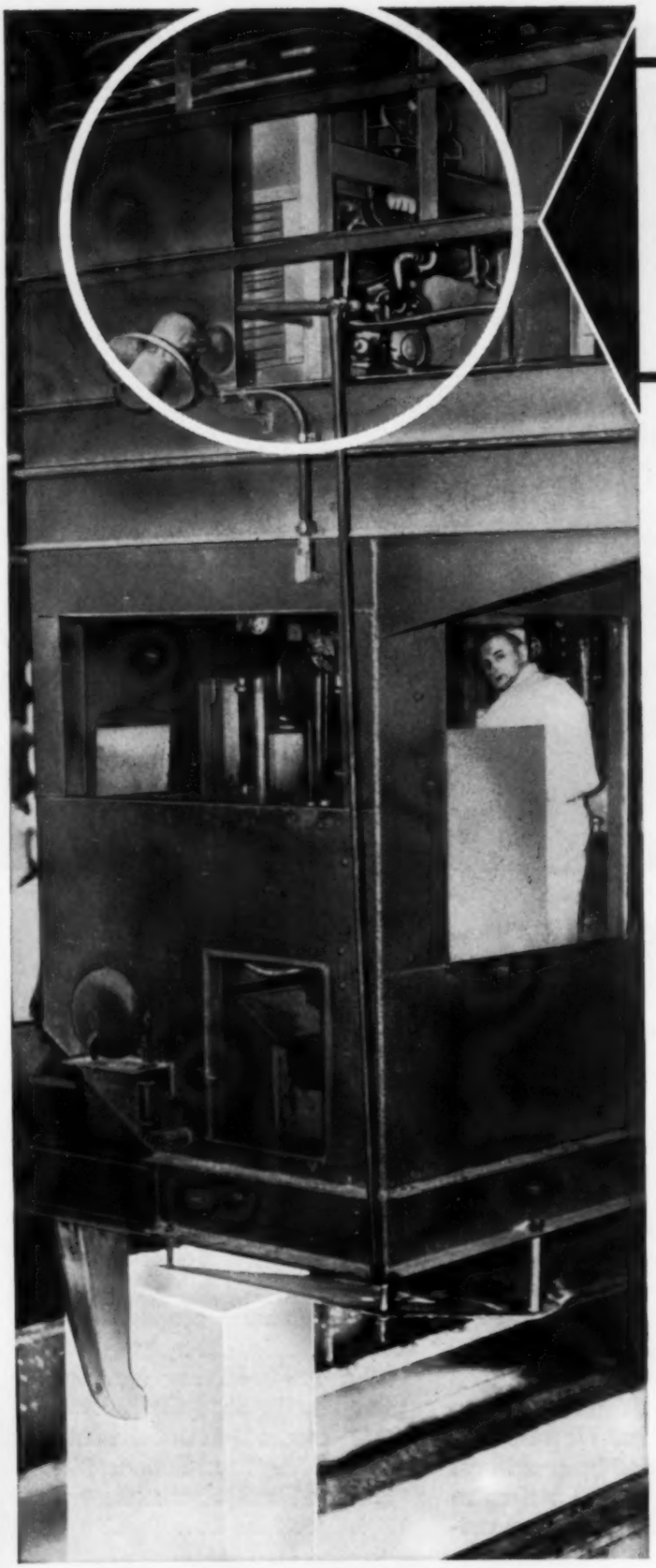
CONDUCTIVITY CELLS

▲ A new series of electrolytic conductivity cells for use with Dynalog conductivity instruments has been developed by the Foxboro Co. The cells are designed for high and low conductivity measurements, detecting the concentration of acids, bases and salts in solution. These chemi-

PRESSURE SWITCH FOR HYDRAULIC SERVICE

This pressure switch manufactured by Benjamin Lassman & Son, for industrial hydraulic service, is of the spring opposed plunger design, built in two ranges; 250-1200 psi and 1000-3000 psi. It is ruggedly designed and constructed and will function consistently on repetitive heavy duty cycles. Adjustment is by means of two hex nuts of extended travel (1¼-in.) thereby eliminating the difficulty of some switches where the setting is extremely sensitive and is limited to a very small arc or length of travel. The switch mechanism is rated 10 amps at 125 volts a-c. Also available for direct current.





DRAVO CRANE CAB COOLERS prevent a working hazard at new Lone Star Mill

In planning its new steel mill, Lone Star Steel Company, Lone Star, Texas went the limit in providing for the safety and efficiency of the crane operators. Sound planning eliminated excessive temperatures over soaking pits and open hearth furnaces and reduced to an absolute minimum the hazards of dust and fumes. This scientific approach to problems heretofore characteristic of the steel industry make Lone Star's new steel division ultra modern in every respect.

Crane Cab Coolers installed on soaking pit and open hearth cranes

Lone Star installed six Dravo Crane Cab Coolers in its plant during construction —three on open hearth cranes and three on soaking pit cranes. The Crane Cab Coolers filter the air, remove dust, dirt and fumes; heat the cabs in winter, cool them in summer and provide year-around ventilation. As a result, crane operators perform their duties under conditions which promote efficiency, alertness, productivity and safety.

Split-type or self-contained units available for immediate delivery

Dravo Crane Cab Coolers are available in two models—the self-contained unit which is installed over the cab, or the split-type unit with the condenser section mounted at any convenient place on the crane and the evaporator section located inside the cab. Both models are available for immediate delivery and can be installed quickly with a minimum of crane downtime. For complete information write to Dravo Corporation, Fifth and Liberty Avenues, Pittsburgh 22, Penna. Ask for Bulletin ZA-1301-02

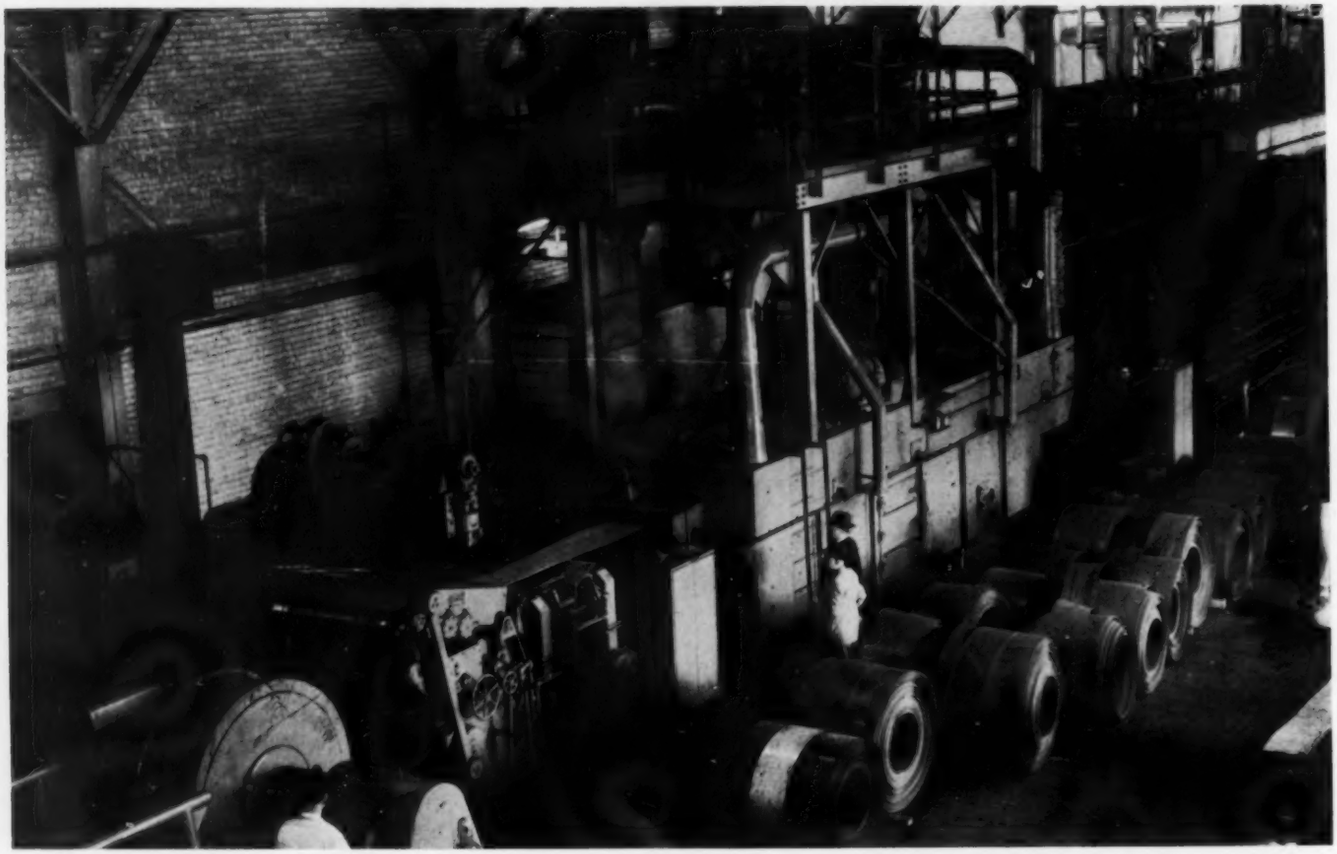
Split-type Crane Cab Cooler on a Lone Star soaking pit crane. Evaporator section is in the cab, condenser section is located on the crane.

ONLY AT DRAVO CAN YOU GET A COMPLETE LINE OF INDUSTRIAL AIR CONDITIONING EQUIPMENT

In addition to Crane Cab Coolers, Dravo also manufactures the new Pulpit Conditioner for use on stationary installations near "hot spots" . . . and a series of conditioners and ventilators for a variety of industrial uses where atmospheric conditions produce working hazards.

DRAVO
CORPORATION
PITTSBURGH, PENNA.
Sales Representatives in Principal Cities

pioneering developments keep **WHEELABRATOR®** *first in blast cleaning*



Blasting Stainless Steel Descaling Costs

Allegheny Ludlum Saves Time, Money and Space with Wheelabrator Descaling

The cost of descaling hot-rolled steel strip and sheet has been drastically cut by mechanical descaling with airless Wheelabrator blast cleaning. At the West Leechburg plant of Allegheny Ludlum Steel Corp., stainless steel strip is descaled without scale breaking. It takes only five men to operate the Wheelabrator descaling line compared to 24 men for the batch pickling operation which it replaced. The Wheelabrator requires only 6,000 sq. ft. of floor space compared to about 10,500 sq. ft. for pickling. The loss of virgin metal has been virtually eliminated and the scale removed is in an easily recoverable condition. Reduction of acid consumption has simplified their acid disposal problem.

Steel is descaled through the controlled impact of Wheelabrator Steel Shot hurled by centrifugal force upon the steel surface to be cleaned. The constant, uniform flow of steel shot from the Wheelabrator units combined with the even, steady movement of the steel through the blast makes this mechanical cleaning method the most efficient descaling process yet devised.

Wheelabrator mechanical cleaning has been profitably applied to etching mill rolls and has effected unusual economics in cleaning strip, sheet, bar stock and skelp. Send now for complete details. Send for Bulletin 894 "How to Descale Steel Strip Mechanically" and Bulletin 914 "How to Descale Steel Sheet at High Speed and Low Cost."

Bulletin 894 tells how to descale steel strip at high speeds and low cost. Send for your copy today.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Ind.

Wheelabrator®
AIRLESS BLAST CLEANING

cals may be present as contamination, or they may be necessary to the process, as in washing, bleaching, pickling, souring and chemical mixing operations.

Low-conductivity cells (constants of 1, .1, and .01) are available in two types, both designed for insertion in a pipeline or a tank. One type includes a valve and fittings to provide for removal of the cell under pressure without interrupting the process. The electrodes are carbon and require no platinization. They can be cleaned chemically or wiped with a cloth or brush.

High-conductivity cells (constants of 10 and 100) are also furnished in two types, one for insertion, the other a dip type for open tanks. The sensitive portion of these cells consists of two platinum electrodes in an H-shaped structure of Pyrex glass tubing. Cleaning is simplified and fouling minimized by mounting the electrodes flush with the inside of the tubing. Cells may be temperature-compensated to prevent errors due to variable solution temperatures.

MEASURING UNIT

▲ A new electronic measuring instrument in many cases 100 times faster and more consistently accurate than conventional galvanometers for making bridge-type measurements has been developed by Minneapolis-Honeywell Regulator Co.

The new instrument, called an ElectroniK Null Indicator, is the first radical departure from the conventionally used galvanometers. Housed in a portable, compact case (which minimizes bench space) the new instrument speeds up resistance and potential measurement by utilizing precision potentiometers and bridges. To operate it is only necessary to close the switch and balance the bridge. The balance point is indicated by the return of the indicator pointer to zero. By contrast, light-beam galvanometers will lose time while waiting for the pointer to cease oscillating, or come back on scale.

In addition, the new instrument is not affected by vibration, one limitation of the conventional galvanometers, nor is it necessary to level the indicator since its operation is unaffected by position. Overloads of several hundred per cent will not affect the new instrument.

The input terminals on the instrument can be used with either pin, spade, or banana jacks.

BELT CONVEYOR

Almost two tons of rich iron ore a second stream along this belt conveyor to a self-propelled shiploader on the dock at Puerto Ordaz, Venezuela. The ocean vessel moored along side is one of the first to carry ore from the Cerro Bolivar mine of Orinoco Mining Co., subsidiary of U. S. Steel Corp. The 65-ft-high shiploader, was designed to operate in any season, despite an annual 39-ft rise and fall in river level. It can be quickly positioned anywhere along the dock. Its pivoted boom can be raised or lowered a total of 70 ft, and the lower shuttle belt can be extended to reach across the broadest ship. One man in the shiploader operating cab controls not only all movements of the shiploader but the speed and capacity of the entire reclaiming system.

CYLINDER HOUSING

This is the main cylinder housing for the 12,000-ton extrusion press designed and built for the Air Force as part of the heavy press program. The installation is to be at Harvey Machine Co., Inc., Torrance, Calif. The casting weighs approximately 363,000 lb and was cast at United Engineering and Foundry Co. New Castle, Pa. plant.

Enterprise PIPE ROLLER CONVEYORS

ENTERPRISE Roller Conveyor Units are modern industry's answer to conveying problems in many mill runout table applications. Two of many outstanding features are individual drives and rugged all-steel construction. These units are versatile, economical and easily installed.

Write for Bulletin 501

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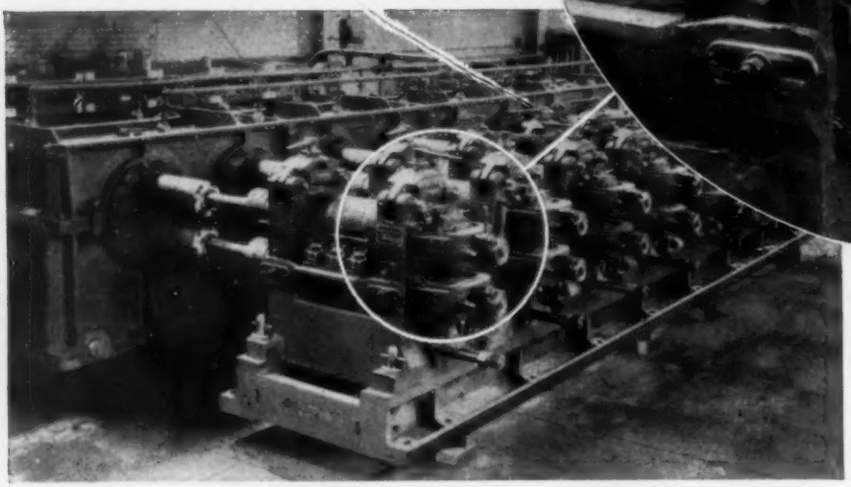
ROLLER-BEARING END ROLL *Reduces Downtime*



Steps Up Production

*End roll adjustment patent applied for.

● The greatest improvement in end roll mechanism made in years . . . permits more accurate and faster end roll adjustment; more flexible operation and minimum maintenance.

The roller bearing is locked to the end of the roll, but may be changed in a jiffy—need not be removed for dressing or until the roll is scrapped. When rolls need changing, patented tilting caps swing up and rolls are raised through top of housing without disassembling end roll adjustment.*

Heavy C clamps secure the bearing housing to the frame with self-aligning surface contact for easy vertical adjustment without wear of clamping surface.

This advanced design typifies the Skill and experience of Birdsboro engineers. We'll be glad to apply our engineering service to your mill machinery problems anytime you say the word.

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SLAB HEATER SIDEWALL

5 years service

AND STILL IN

GOOD CONDITION

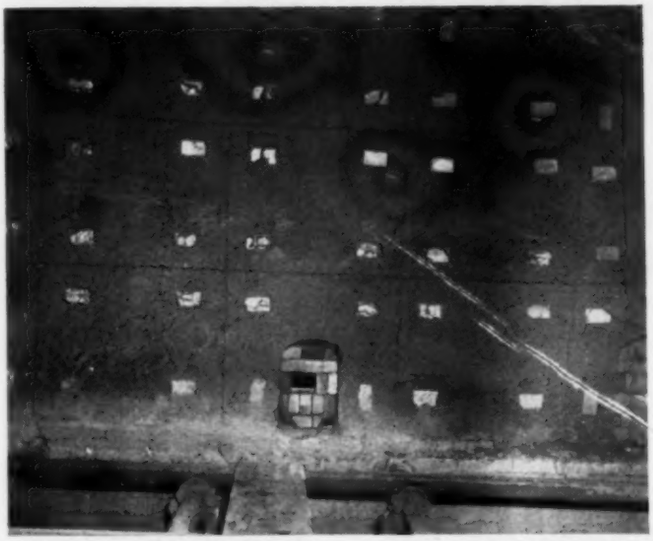

Fig. 1 — Picture of Ramtite Side Wall taken after one year service with no maintenance.

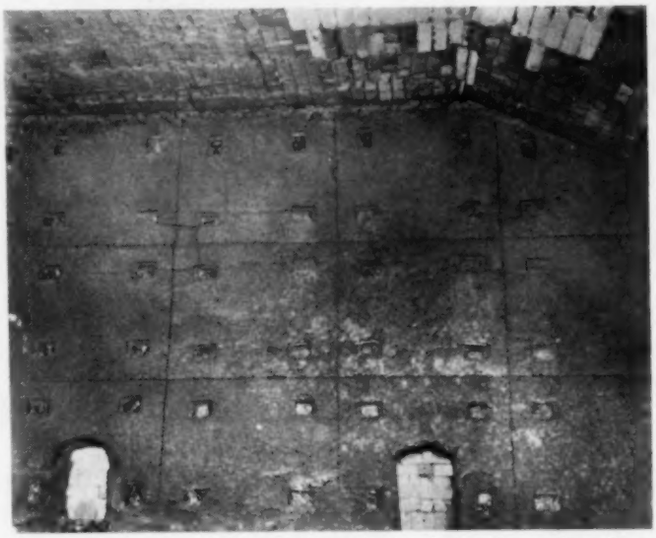

Fig. 2 — The same area as shown in Fig. 1, after three years service with no maintenance.

Fig. 3 — Still good after five years service, the only maintenance required has been the filling in the holes left by the spalled anchor ends.

PHOTOGRAPHS, COURTESY UNITED STATES STEEL CORPORATION

This Ramtite sidewall has paid for itself over and over again with five years uninterrupted, economical service with less than $50.00 maintenance, in the No. 1 Continuous Reheat Furnace, 96" Plate Mill, United States Steel Corporation's South Works, Chicago, Illinois.

Ramtite Plastic Refractory has given outstanding service in this type of application, not only to United States Steel, but also to many other users. The good service record is due partly to the monolithic construction with Ramtite — eliminating joints, cracks and air space. The inherent spall-resistance, Ramtite's natural tolerance toward physical and thermal shock; and the extremely low drying and firing shrinkage found only in Ramtite Plastic Refractory contributed equally to this new service record.

In Continuous Reheat Furnaces, Ramtite can be used for flat roofs, sloping roofs, knuckle noses, burner cones and walls, sidewalls, and door openings, in all zones. Ramtite, used with just one fired shape — the patented SAFE-TIE ANCHOR©, can be used for any or all of the above applications, as well as many others, resulting in a great reduction of your refractory inventory, and a substantial saving in warehouse space.

Here is a simple, painless way to get the answer to your refractory problem: Just contact your local Ramtite man. He's experienced in the refractory field, and he will gladly give you any information or assistance possible.

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PLASTIC • CASTABLE • GUNNING REFRACTORIES

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City.....Zone.....State.....

This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry.

"35,159 Payroll Savers in Southern Bell . . ."

MR. FRED J. TURNER,
President, Southern Bell Telephone and Telegraph Company

"Thrift is an old-fashioned virtue that has never gone out of style in America. It is one of the foundation stones on which our material well-being as a nation is built. The payroll deduction plan for the purchase of U. S. Savings Bonds provides a particularly convenient way for the individual to practice thrift, to invest in his country, help provide for its security, and accumulate a stake for the future."

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• Thanks to the support of the Payroll Savings Plan by industry and business, and the thrift of millions of Payroll Savers, the *cash value* of Savings Bonds held by individuals amounted to $36,663,000,000 at the end of 1953.

What's good for Americans is good for America.

• Sales of E and H Bonds in 1953—22% higher than in 1952—provided cash for *all* E and H Bond maturities and redemptions and still left more than $210,000,000 net, for the reduction of the debt.

• Think of the reserve of future purchasing power represented by the more than $49,000,000,000 in Savings Bonds, cash value, held by thrifty Americans.

A telegram, phone call or letter to Savings Bonds Division, U. S. Treasury Department, Washington, D. C., will bring you all the help you need to install a Payroll Savings Plan or build employee participation in your present plan.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

IRON AND STEEL ENGINEER

TESTS DEMONSTRATE EFFECTIVENESS OF...

Trade Mark

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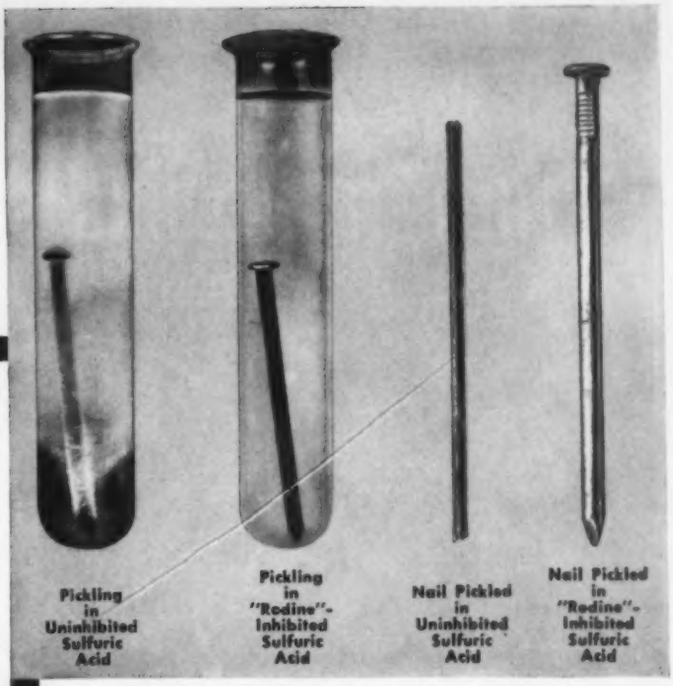
Reg. U.S. Pat. Off.

PICKLING ACID INHIBITOR

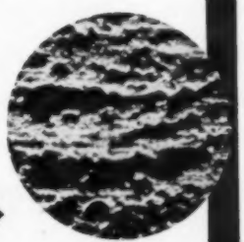
"Rodine" more than pays for itself in savings of acid and metal. More uniform pickling and better pickled surfaces are obtained when "Rodine" is used in acid pickling baths.


Pickling in Uninhibited Sulfuric Acid
Pickling in "Rodine"-Inhibited Sulfuric Acid
Nail Pickled in Uninhibited Sulfuric Acid
Nail Pickled in "Rodine"-Inhibited Sulfuric Acid

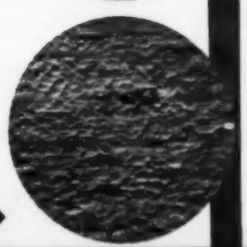
The photographs above illustrate the beneficial effect produced by a small amount of "Rodine" in a pickle bath.

A. Both test tubes contain a 10 per cent by volume solution of sulfuric acid. In the left-hand tube, no further additions have been made to the acid. Notice the gas bubbling off the nail. This is hydrogen, caused by the action of acid on good metal. In the right-hand tube, "Rodine" has been added in an amount equal to 1 per cent by volume of the concentrated acid. Notice the absence of bubbling in this tube. "Rodine" prevents the formation of hydrogen that results from dissolving metal.

B. Both nails after being pickled for the same time. The nail pickled with "Rodine" has lost little weight and has retained its original luster and appearance. The nail pickled without "Rodine" is no longer a nail. "Rodine" prevents the acid from dissolving metal.



This steel surface was pickled in an uninhibited acid bath. Note the deep pits, and that the surface is visibly crystalline.



This surface was pickled exactly like the one above except that "RODINE" was added to the acid solution. Only scale pockets and roll marks are visible; no pitting occurred.

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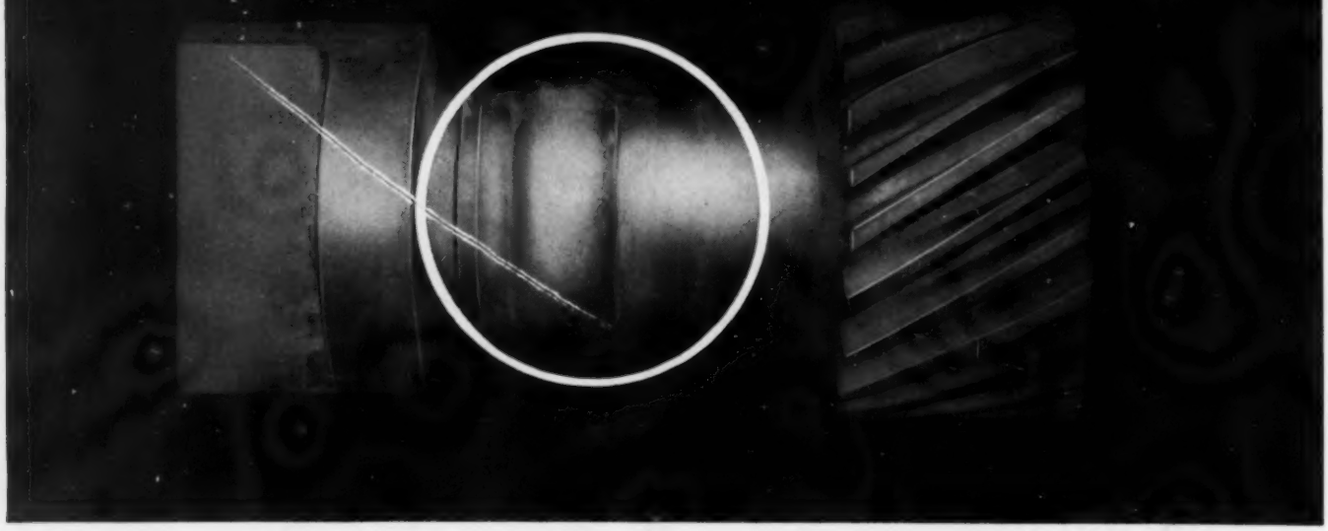

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Control Valves

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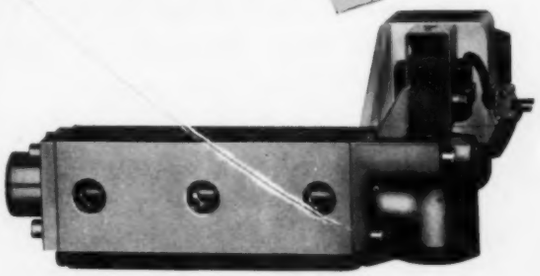

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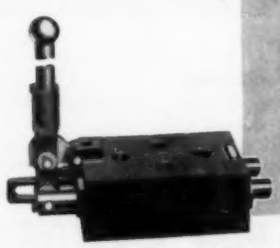

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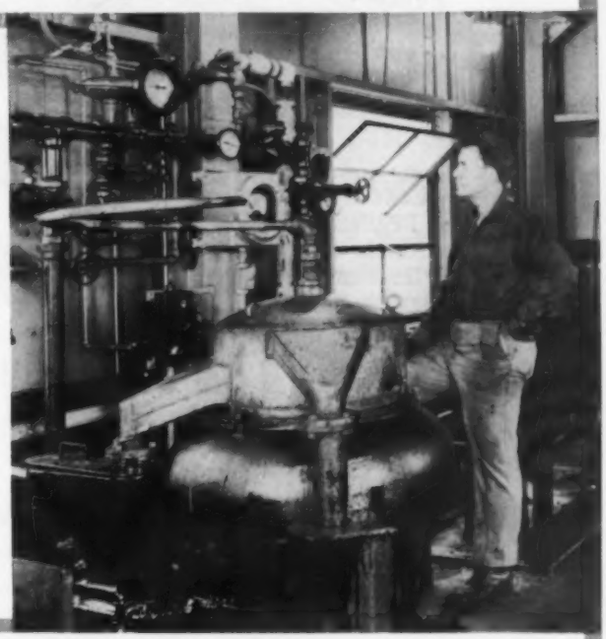

- **Increase Distillation Rate**
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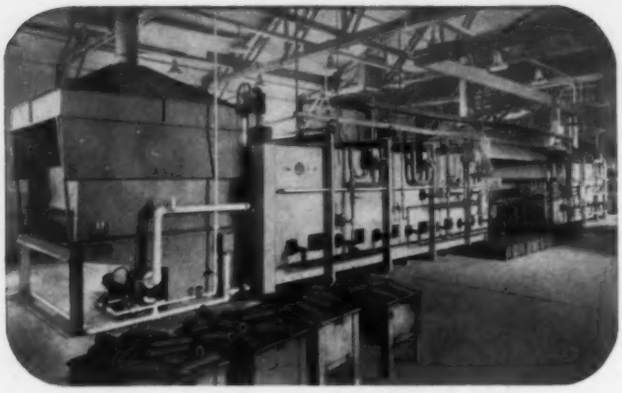
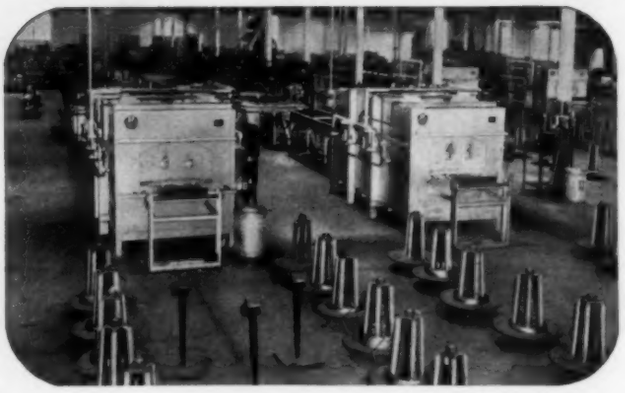


One of our recent EF continuous heat, quench and draw units uniformly scale-free heat treating shell forgings.



A recent installation of five EF special atmosphere continuous furnaces bright annealing stainless steel wire.

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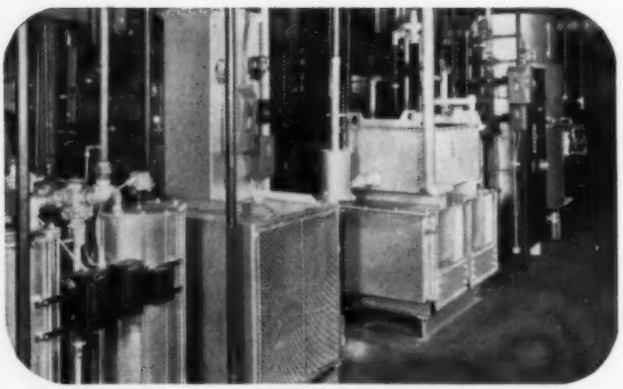

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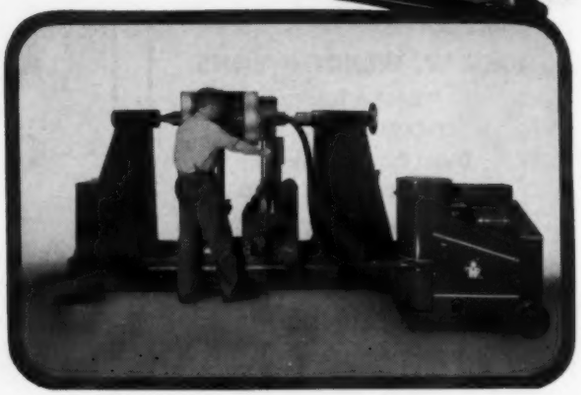

Peerless Universal Armature Machine (top) with Commutator Grinding Attachment, Standard Banding Tension Device. (Below) Peerless Type DS Undercutter with Vacuum mica dust collector.

THE PEERLESS Universal Armature Machine and the Commutator Undercutter are the heart of a cost-cutting modern Diesel repair shop. Look what you get with these extra-heavy duty, multi-purpose machines . . .

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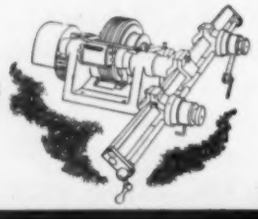

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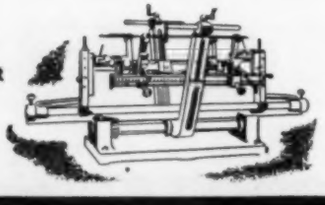

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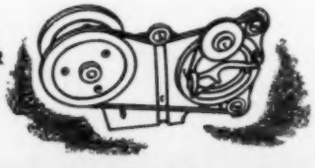

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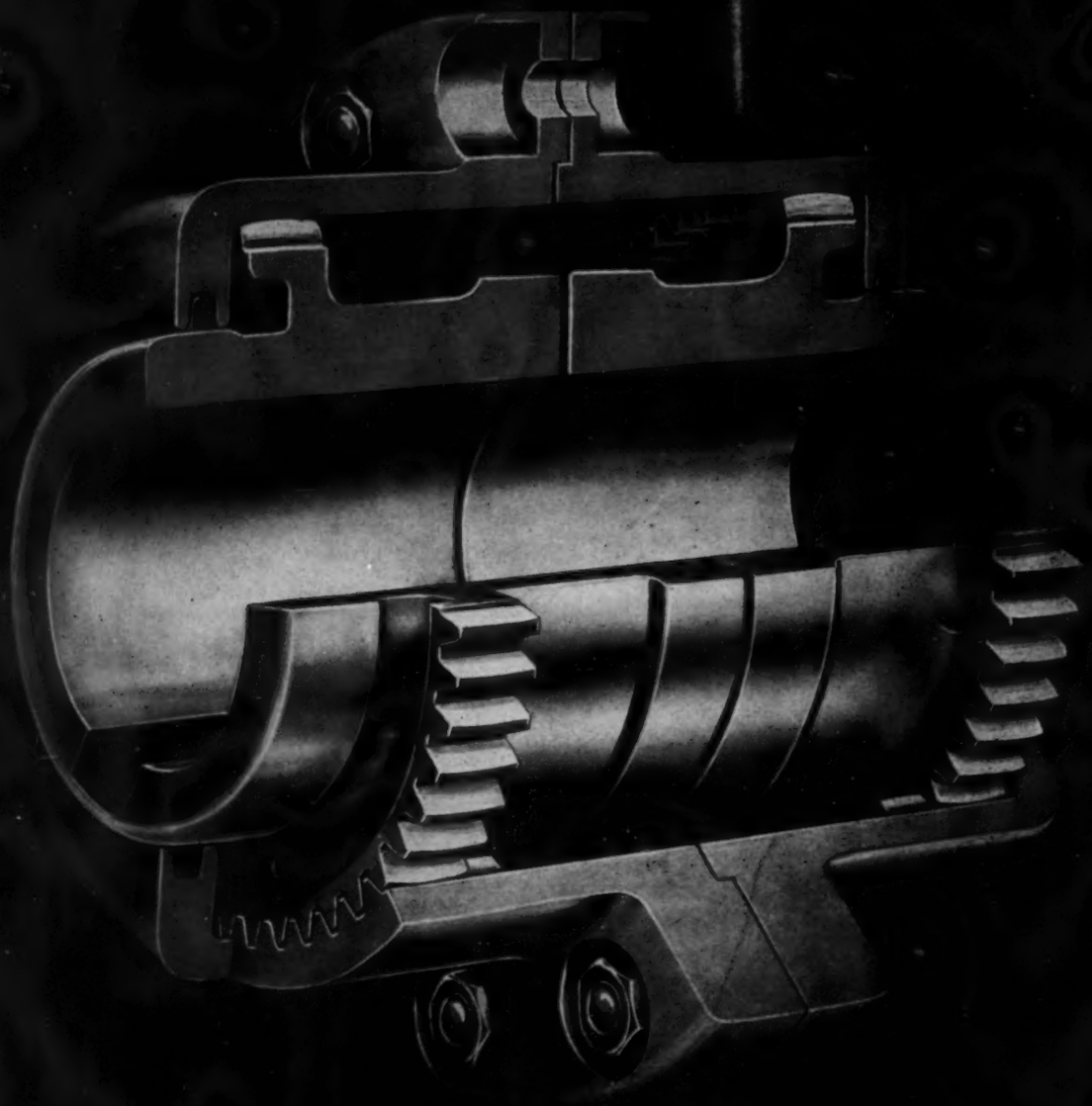

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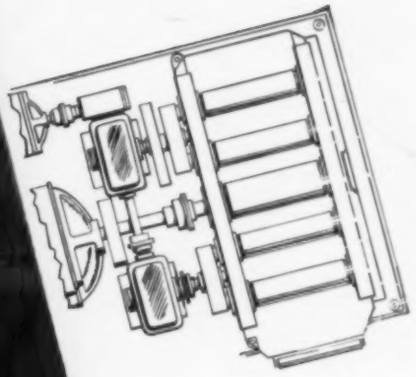

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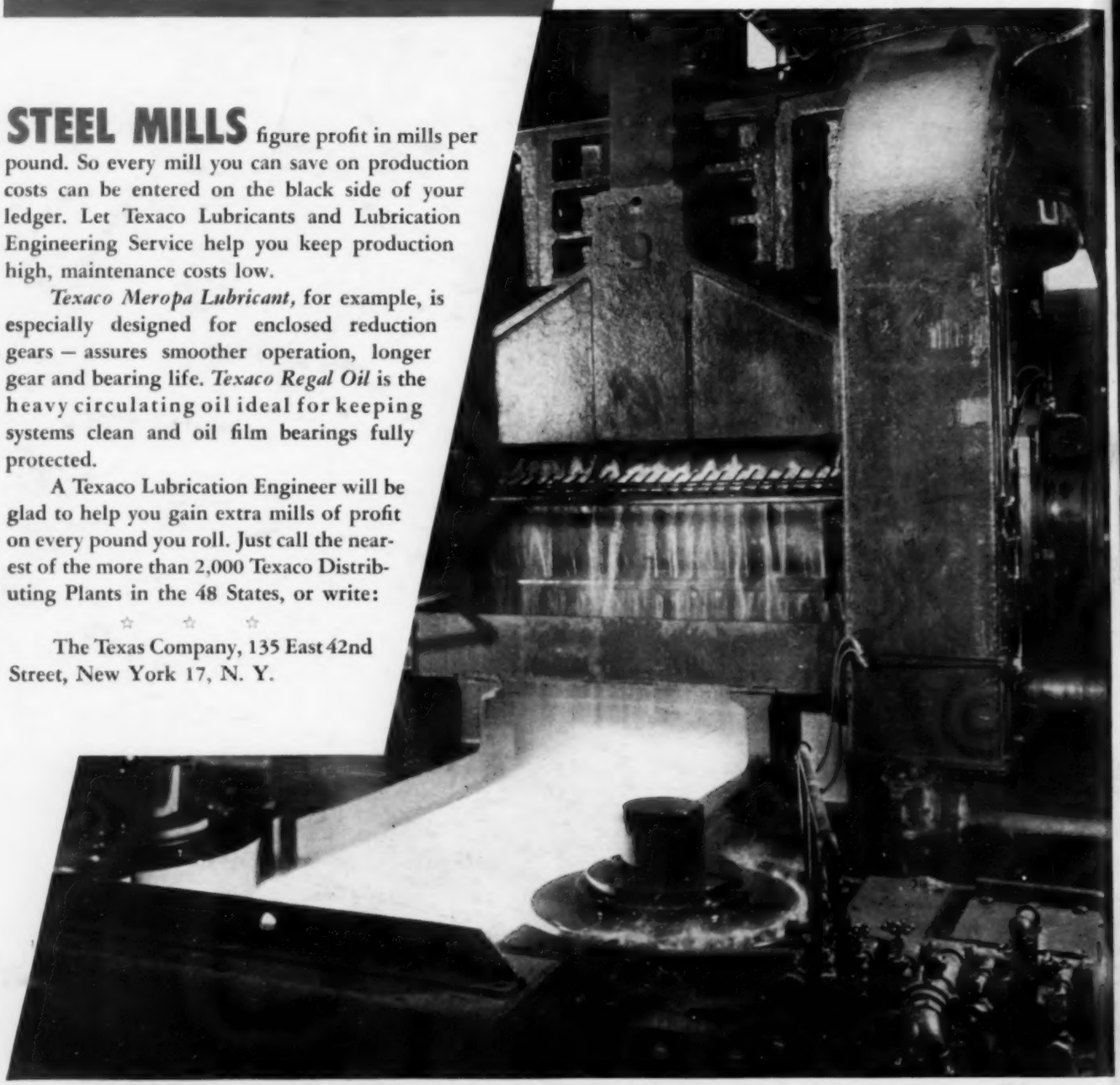

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